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Acid Resisting Metal Unique

Castings Made of High-Silicon Iron Melted and Remelted in an Air Furnace with the Addition of 50 Per Cent Ferrosilicon—Metal Hard and Brittle, Easily Welded, but not Machineable

BY H. E. DILLER

IRON in its pure state is a soft ductile metal, but when it becomes associated with other metals or elements it frequently changes its physical properties so markedly that one must be familiar with it to be able to recognize it. The associate which has probably the strongest effect on this much varied metal is carbon. Added in small percentages carbon gradually increases the strength of the iron until at about 1 per cent the point is reached where by quenching in oil or water the metal may be hardened almost glass hard, and subsequently drawn at a few hundred degrees Cent. to toughen it the metal becomes a good grade of tool steel. So with varying amounts of carbon and different heat treatments the soft iron is turned into all the many grades of soft or hard steel, and with the addition of small amounts of other metals such as tungsten, chromium, nickel, vanadium, etc., its physical properties may be changed in certain directions. Rolling or forging also govern to a limited extent the physical characteristics of the metal.

When cast, the variety of strengths and elongations which can be obtained from iron are somewhat limited, but even in this condition its strength and elongation may be varied widely. Then with the addition or absorption of more carbon the well known product, gray iron, is secured. This is a somewhat sensitive metal, for unless its associates are picked carefully and in prescribed amounts it will not answer the purpose for which it is intended. So the foundryman must know his iron. The man casting heavy work continually must study new problems before he can master the metal for cylinder castings. He must consider the effects of other elements besides carbon, especially silicon, which has as much control on the carbon as the carbon has on the iron. Given the right amount of silicon, the metal is

FIG. 1—THE METAL IS MELTED IN AN AIR FURNACE SIMILAR TO THE TYPE USED FOR MELTING MALLEABLE IRON—NOTE THE SPRAY OF WATER IN FRONT OF THE DOOR AT THE RIGHT FOR COOLING THE SLAG PULLED FROM THE FURNACE

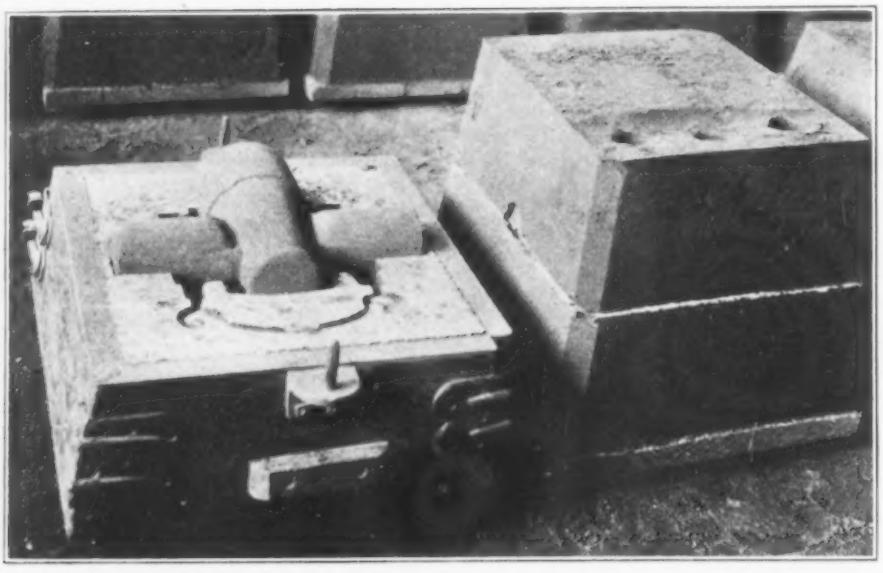


FIG. 2—THE METAL HAVING HIGH SHRINKAGE, THE CASTINGS MUST BE FED WHILE COOLING—NOTE THE POURING GATE WITH A RISER AT EACH SIDE OF IT

soft and easily machineable, but with too little silicon it is hard and brittle.

Strangely, the effect of excessive amounts of silicon on the physical properties of the iron is somewhat similar to that of low silicon although the reactions arise from the formation of different compounds with the iron. Under both conditions an iron eminently suitable for certain purposes is produced. The hard white iron resulting from too little silicon is fitted for castings where an extremely hard surface is necessary, as for the treads of car wheels, for rolls, crushing surfaces, and for many other purposes. Castings with a high silicon content are useful for their acid resisting properties.

While the production and properties of white-iron castings with low silicon generally are fairly well understood by foundrymen, the high-silicon iron is not well known. This is due to the wider uses found for the white, or chilled, iron castings and the comparatively limited field for the castings of high-silicon metal. These are used principally for parts which must resist the action of acids. Thus the field for this class of castings being limited, only a few firms produce them, and these are specially equipped and must have a thorough knowledge of the metallurgy of the metal.

One of the firms specializing in acid resisting metal is the Duriron Co., Dayton, O. This company after a number of years of experimental and production work has adopted a metal of the following composition:

	Per cent
Silicon	14.25 to 14.75
Sulphur	about 0.03
Phosphorus	About 0.10
Manganese	About 0.25
Total carbon	less than 1.0

This metal derives its hardness and acid-resisting properties from the formation of iron silicide instead of iron carbide which gives the hardness to the low-silicon white iron. In the high-silicon iron the carbon is practically all in the free state scattered through the body of the metal in thin flakes. The physical characteristics of this metal are indicated by the facts that its tensile strength is only about 10,000 pounds per square inch, it is brittle without any ductility, and it is too hard to machine.

The composition given here has been found by the Duriron company to be the best commercially for acid resisting castings, both from the foundry standpoint and for its acid resisting properties. The effect of silicon on iron is indicated by the chart, Fig. 3. This chart was plotted from an article by O. L. Kowalke included in the *Transactions* of the American Electrochemical society, volume 31, 1917. It shows the percentages of metal lost when subjected to the action of 10 per cent solutions of nitric, hydrochlorie and sulphuric acid for seven days. In all cases the losses are high until the silicon content reaches about 14 per cent when the loss is extremely small in each case. The effects of the acids upon irons with different amounts of silicon is interesting, showing as it does in the case of hydrochloric and sulphuric acids a large increase at certain points.

High silicon is secured and the sulphur and phosphorus are obtained in low percentages through the use of bessemer ferrosilicon stock. A low-sulphur coal used for melting the iron in an air furnace prevents the metal from picking up much sulphur from the fuel. The air furnace used for melting the

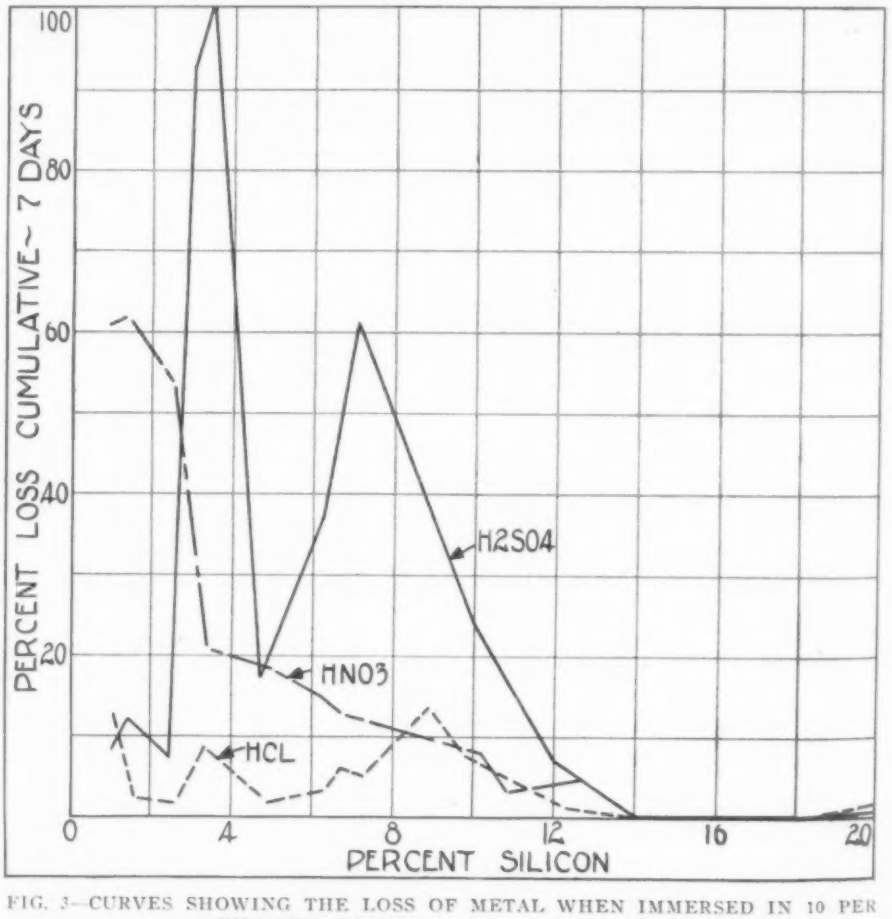


FIG. 3—CURVES SHOWING THE LOSS OF METAL WHEN IMMERSED IN 10 PER CENT ACID SOLUTION FOR A GIVEN TIME

metal is, like the type used for melting malleable iron, made of firebrick and has a sand bottom.

The design of the furnaces used at the Duriron plant is slightly different from the usual malleable iron furnace. The former has a slightly higher roof which is nearly level so as to keep the flame from being deflected onto the metal bath. This is necessary to prevent the excessive loss of silicon by oxidation. Another precaution to protect the metal from undue oxidation is in the use of lime and glass to form a pasty slag covering the bath. This is added with the charge in the furnace.

A view of the furnace is shown in Fig. 1, which gives an idea of the shape and height of the roof. The two furnacemen are poling the metal and pulling off the slag. The furnaceman at the left pushes the slag toward the door at the right and the second furnaceman pulls it from the furnace. This would be extremely uncomfortable work for him if the slag were not cooled by a spray of water which may be seen in front of the door at the right. In this illustration it may be noted also that the stack is not directly at the end of the furnace, but the flue carries the gases under the floor to a stack on the outside of the building. The top of the flue offers a convenient means for drying the hand ladles, some of which may be seen on the sloping surface at the right. Like the average hand-fired, malleable-iron furnace, a blast of air is used under the firebox and another blast is introduced through the roof where the flame enters the melting chamber, furnishing more oxygen to the flame from the coal, which is highly reducing at that point. The blast is supplied by a blower located near the firebox on the side of the furnace opposite to the one in which the slag doors and tapping spout are located. This blower which furnishes 3000 cubic feet of air per minute at a pressure of 3 ounces is driven by a 7½-horsepower motor.

Before studying the production of castings a general knowledge of the plant will be of interest. The establishment was built in 1918 on a 19-acre plot of ground on the outskirts of Dayton, between the tracks of the Big Four and the Erie railroads. The main building containing the foundry and machine shop is 100 feet wide and 500 feet long. 300 feet of which is devoted to the foundry. It is divided into two side bays and a center bay with a monitor roof. A number of smaller buildings, housing the core room, the testing and research laboratory, pattern storage, forge shop, offices, etc., are grouped conveniently around the main structure.

Sand and coal are brought into the foundry in railroad cars running on a track which extends into one end of the foundry at the middle. This material then is unloaded by grab buckets carried by one of the cranes, of which the foundry is provided with two of a capacity of 15 and 10 tons respectively. Another crane of 5-ton capacity serves the machine shop.

Metals are stored at the side of the foundry and brought to the two 15-ton melting furnaces placed in the center bay, by cars operating on an industrial track. As has been mentioned, the basis for the original charge is bessemer ferrosilicon containing 13 to 14 per cent silicon, 0.02 to 0.03 per cent sulphur, 0.08 to 0.1 per cent phosphorus and 0.18 to 0.34 per cent manganese. This is melted with the required amount of 20 or 50 per cent ferrosilicon to bring the bath up to the desired percentage of silicon. This is then poured into one of the 7½-ton ladles used in the shop and carried to the end of the building where it is poured into a pig bed and allowed to cool. Being quite brittle it

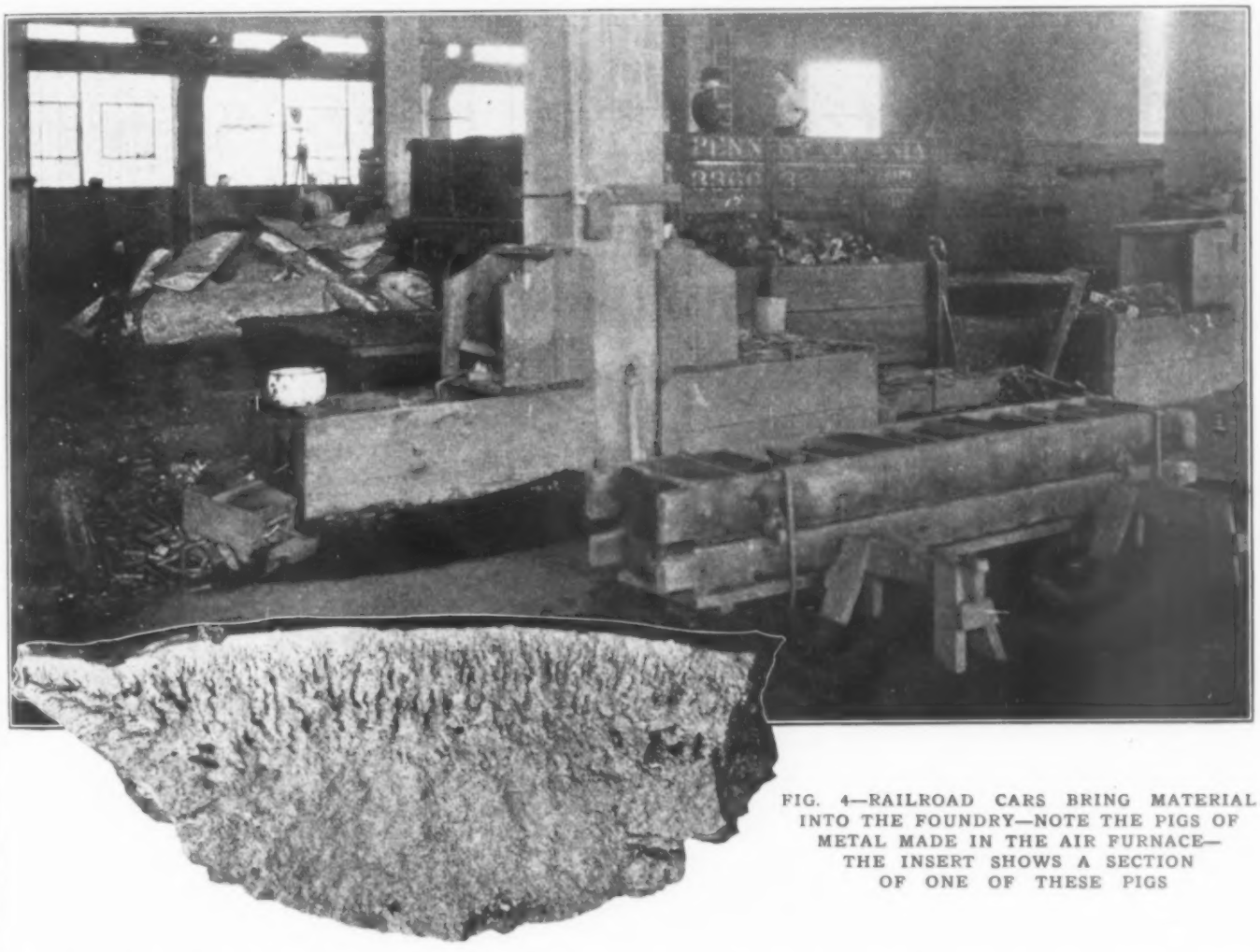


FIG. 4—RAILROAD CARS BRING MATERIAL INTO THE FOUNDRY—NOTE THE PIGS OF METAL MADE IN THE AIR FURNACE—THE INSERT SHOWS A SECTION OF ONE OF THESE PIGS

then is broken easily into suitable lengths for recharging into the furnace. Fig. 4 shows a portion of the pig bed with some of the broken metal at the left. This illustration also shows the method of bringing cars into the building. In the foreground may be seen a skip of coal ready to be delivered to the furnace.

It is necessary to pig the first melt of iron because the excess carbon, which is prevented from burning out of the metal by the large percentage of silicon contained, settles out as kish and gas holes are formed in the metal. In the insert, Fig. 4, which shows a fracture pig of the metal from a pig heat the gas holes and graphite are indicated by the black marks shown near the upper surface of the pig. With the metal freed from gases and excess carbon it comes solid when remelted with back scrap and poured into castings.

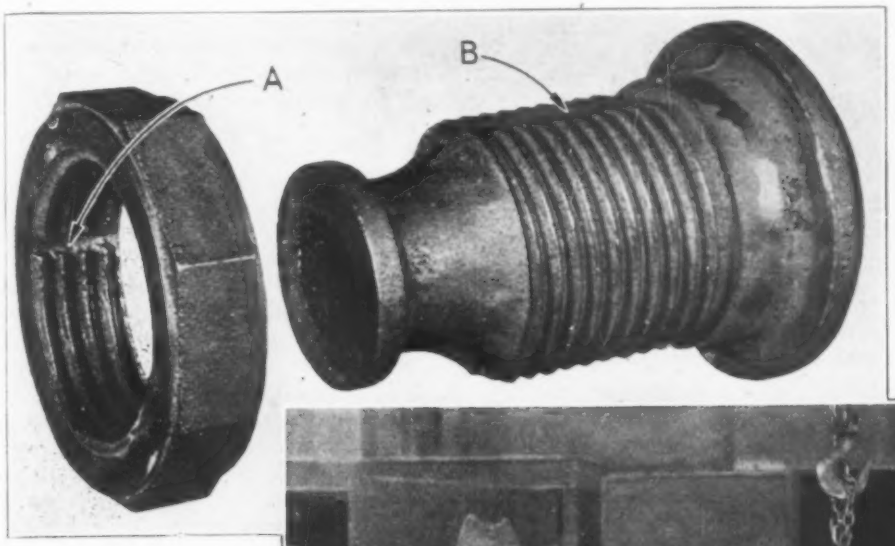
Usually not more than two heats a day are taken from a furnace, but during the war when acid resisting castings for nitric acid plants were so urgently needed, three heats a day were poured from one furnace operating day and night. The metal is poured from the furnace into 7½-ton ladles for the heavy work. As two of these ladles can be poured at once, the shop has a capacity for producing castings requiring 15 tons of metal. Metal for the smaller castings is caught directly from the spout of the furnace. The surface tension of the metal being high, it is necessary to pour it strong and hot. Also, the shrinkage is high, so casting must be fed while cooling. Fig. 2 shows some molds for a three-way plug cock body which indicate a method of gating this metal. As may be noted from the mold on the right three openings are in the cope. The center one is used to pour the metal which drops to the parting line and then is divided by two runners which tap into the casting. This is illustrated by the drag at the left which shows two hollows at each side near the casting, which come directly under the holes in the cope. The holes in the cope when filled with metal act as risers to feed the casting. Both the cope and drag of these molds are made on a stripping-plate machine made by the International Molding Machine Co., Chicago.

Pipe is another type of casting made extensively by this company. In the core for a pipe mold a different problem is presented than for the core of a similar mold made for gray iron. In the gray-iron mold chaplets may be used to hold the core in position, but with high-silicon iron it is not possible to get a satisfactory casting when using chaplets. In the first place, the iron will not knit to the chaplet and so a leaky casting is produced when the chaplet is used. Even though the iron did knit to the chaplet, if formed of steel, the chaplet would produce a spot easily attacked by acid. Therefore it is necessary to use a heavy rod in both sections of the core to support it. Fig. 5 shows a coremaker ramming a section of a core for a pipe 2 inches inside diameter. In the under section of this core a ¾-inch rod is used, and a ⅝-inch rod is needed for the upper section. The under section is rammed first and a number of them are placed on a steel plate drier. After this section is dried, the drier is brought near the coremaker's bench and when he rams a top section he puts on paste and lays one of the dried sections on it. The whole is then rolled over on another drier, the corebox is lifted off and sand is tucked under the core to prevent it from rolling over. It then is necessary to bake the core again. These heavier cores are dried in a double, car-type, coke-fired oven while a drawer-type oven, also coke fired, serves to bake the smaller cores. Many of the cores are made from an oil-sand mixture prepared in a mixer supplied by the Blystone Mfg. Co., Cambridge Springs, Pa. As may be noted from Fig. 5, this core room which is 60 x 100 feet is well lighted, the side walls being composed almost entirely of glass. Patterns for the pipe are mounted and molded in the usual way when the pipe is of standard dimensions, but a great many orders for odd lengths of pipe are received and a large stock of patterns, many of which are not needed frequently, is necessary. To lessen the number of patterns, movable collars are placed on the patterns as shown by Fig. 6. The collars are made of aluminum and screwed onto the wooden barrel pattern. The collar at the right is movable, so when an order is received for pipe of the diameter of the barrel pattern the collar is moved to the required distance and the order number together with the length of the pattern are stamped on a metal strip which is tacked to the pattern. The other strip of metal shown on the pattern, Fig. 6,

FIG. 5—CORES FOR PIPE REQUIRE HEAVY STIFFENING RODS BECAUSE CHAPLETS CANNOT BE USED FIG. 6—THE LENGTH OF THE PIPE IS DETERMINED BY THE MOVABLE COLLAR

is the pattern number. With this precaution of marking the order number and length of pipe on the pattern, danger of mistake in getting the wrong pattern is removed and the pipe casting easily is identified.

The metal being so hard and brittle, the cleaning room and finishing problems are somewhat different from those of the gray-iron foundry. The fins are readily broken off with a hammer, but the rough places must be finished by grinding instead of machining. Sand is



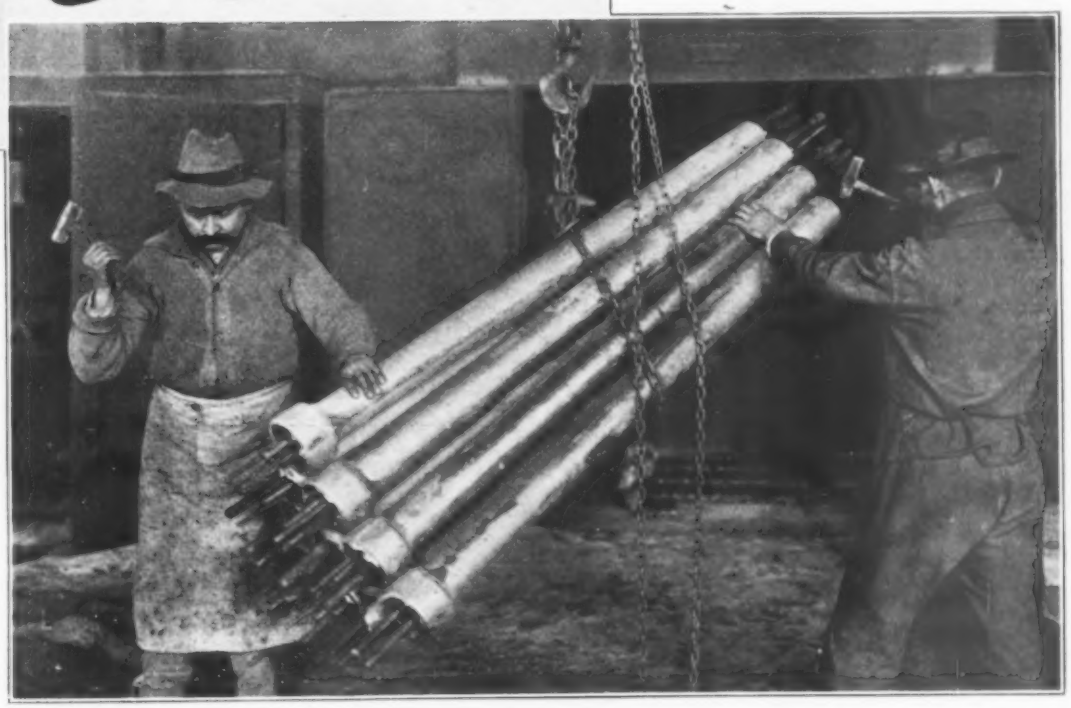


FIG. 7—THREADS MUST BE BROKEN AT THE PARTING LINE AS THE CASTING CANNOT BE MACHINED FIG. 8—THE CORE RODS ARE KNOCKED OUT OF THE PIPE BEFORE IT IS SANDBLASTED

removed in a sand-blast room, 8 x 20 feet, built by the W. W. Sly Mfg. Co., Cleveland. A difference is noted from the sand-blasting of gray iron in that approximately twice as much sand is used for doing the same amount of work, the sand grains being split more rapidly in striking against the hard metal.

Pipe are brought into the cleaning room by the crane as shown in Fig. 8, and the stiffening bars are knocked out on the floor as indicated. The pipes then are laid at the end of a low roofed compartment, open at the end the pipes enter and having a suction at the other end to carry off the dust. Then compressed air is blown through the pipe to remove the burned core sand and prevent it from being mixed with the sand-blast sand in the cleaning operation.

After the pipes are taken from the sand blast they are piled on wooden skips with high ends and carried by the crane to the grinding department. Here the fins formed at the partings are ground off by the use of swing grinders as illustrated in Fig. 9, the heavier pipe being handled by a chain fall traveling on an I-beam.

As the metal cannot be machined a problem is presented when a threaded casting is ordered. In some of these castings which have a fine thread a threaded steel nipple is set in the mold and the metal is poured around the inner surface and ends, fixing it solid in the casting. This method formerly was pursued with all threaded castings but it was found that the heavier threads could be cast on the casting if the thread was broken at the joint to obviate the difficulty encountered from the parting when the entire thread is cast. A parting in the thread would leave a fin which would be extremely difficult if not impossible to remove. By breaking the thread in the mold as indicated in Fig. 7 this trouble is avoided. This shows the threads broken at the partings in both the internal and external threads, as indicated at *A* and *B*.

Although the castings cannot be machined they can be welded successfully with the oxyacetylene torch, using a flux to prevent oxidization and to clean the metal. The Duriron company uses a flux made of 59 parts by weight of borax, 18 parts of sodium bisulphate and 23 parts iron oxide. Like other iron or steel castings these also must be preheated before welding. Fig. 10 shows the welder putting a steel nut on a pump runner casting to allow the centering to take hold when the casting is centered in the grinding machine for finishing. The preheating furnace may be seen at the right in the same illustration.

The welded nuts are removed after they have answered the purpose for which they were intended by boiling the castings in sulphuric acid. This method also is employed for removing steel pieces used to core certain castings. Long tube castings such as those shown in the foreground at the left are preheated by laying them one at a time in the clay-lined steel boxes shown at *C*, Fig. 10. The tube lays in a groove and the flame from an oil burner strikes the casting through the opening which is shown at the front of the box.

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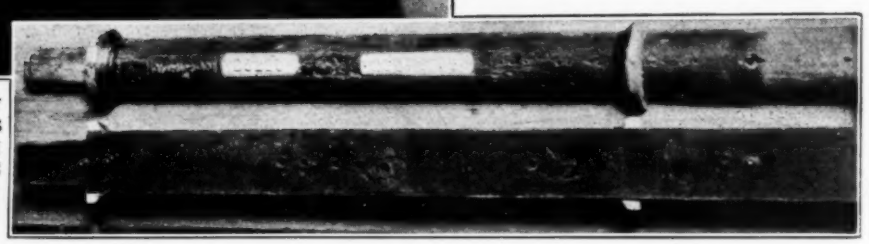

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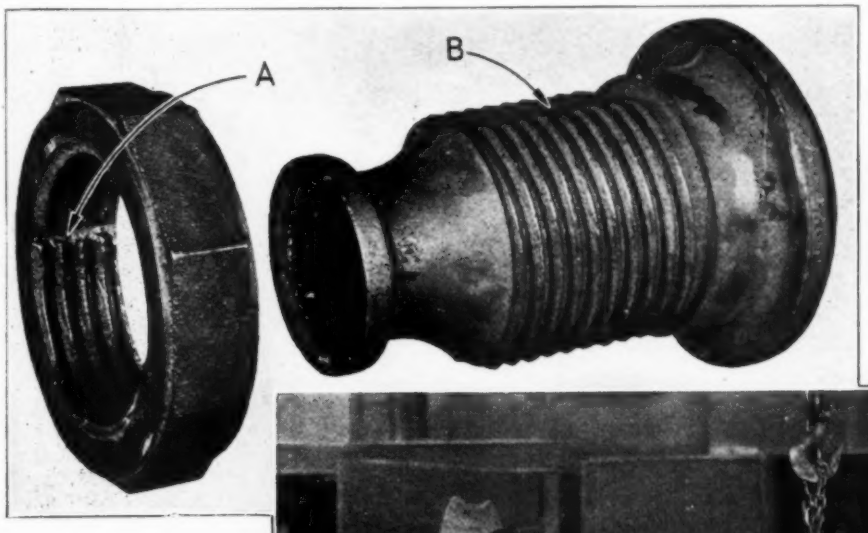

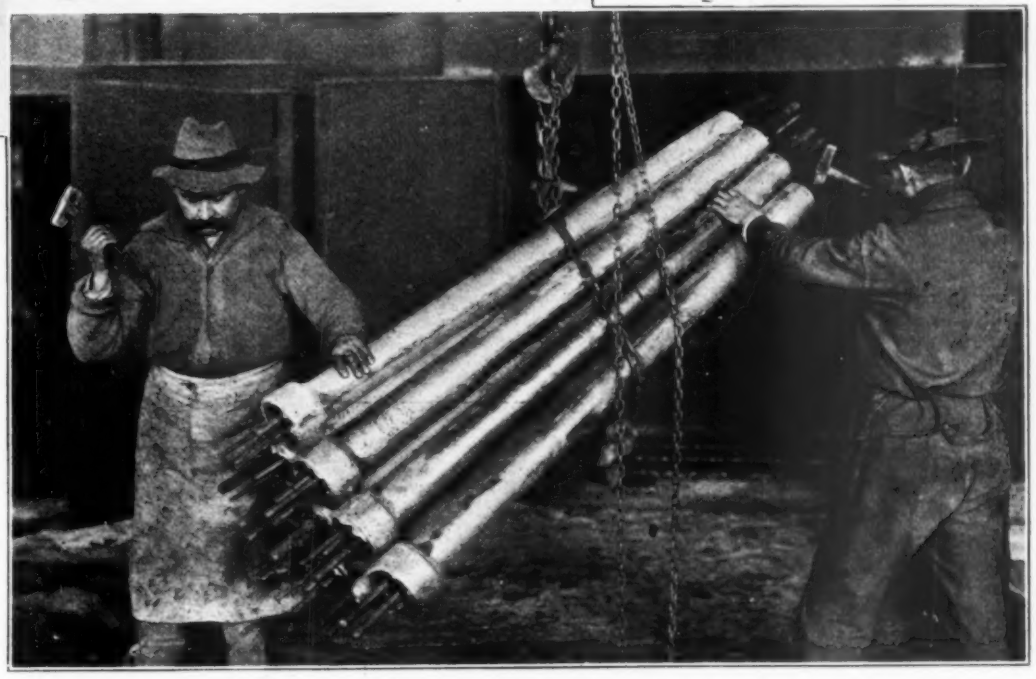

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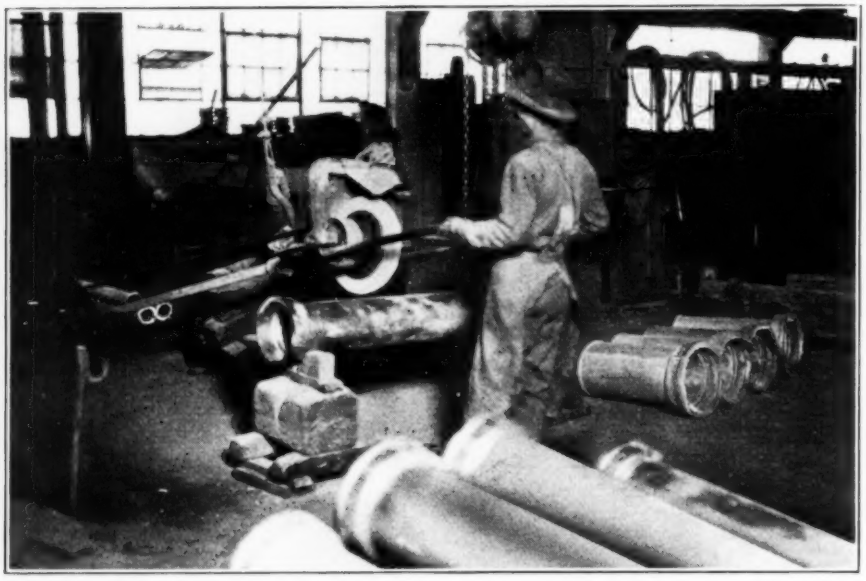


FIG. 9—THE FINS AT THE PARTING LINE ARE SMOOTHED OFF BY SWING GRINDERS

of complicated parts which it is difficult to cast as a unit. After the castings are ground and ready for shipment they are crated to prevent breakage.

While the production of pipe has been described specifically, the company makes a great variety of castings, some of which are of complicated design such as those for pumps, kettles for stills, etc. The company also makes gray-iron castings of air-furnace iron. These are principally for the machinery it manufactures, or for chemical or pressure work. The iron being of such a different composition from that of the regular gray iron, the ordinary methods of chemical analysis used for gray iron are not satisfactory for this high silicon metal. In the first place, the metal being highly resistant to the action of acids it is not readily soluble in the acids used to dissolve samples of gray iron. Then, too, the excessive silicon interferes in determining the other elements.

For determining silicon, the sample is dissolved in aqua regia and taken to near dryness. After cooling, a mixture of nitric and sulphuric acid is added and the solution taken to fumes and baked. The same procedure of taking up with hydrochloric acid, filtering, washing, igniting and weighing as SiO_2 is then followed. Also with this high percentage of silicon it is necessary to volatilize the SiO_2 in the crucible with hydrofluoric acid.

To determine carbon by the combustion method some other substance such as carbon-free iron must be added with the sample to produce the necessary heat to induce complete combustion. The addition of 1½ gram of finely divided carbon-free iron added to 1 gram of sample has been found to be satisfactory. A blank must be run, using the carbon-free iron without the sample to determine any traces of carbon in it. In case a carbon-free iron is not readily obtainable a commercial iron with extremely low carbon may be substituted and the blank subtracted from the results secured from the determination.

Sulphur must be determined by the oxidation method. The sample is dissolved in a mixture of concentrated nitric and hydrofluoric acids, and after solution is complete, a few cubic centimeters of nitric acid are added and the solution evaporated to dryness. Then, after cooling, 10 to 15 cubic centimeters of dilute nitric acid are added and the solution again taken to dryness. This is repeated two or three times. Sodium carbonate is then added in small proportions until in slight excess. This is then filtered and the filtrate, which contains the sulphur is freed of calcium fluoride and calcium carbonate by precipitation with calcium chloride. The determination is finished as in the determination of sulphur in gray iron, by the oxidation method. Of course, a glass or porcelain container cannot be used when getting the sample into solution on account of the presence of hydrofluoric acid, so a platinum, or platinum substitute, dish must be utilized.

For phosphorus, the molybdate method is used and for manganese the sodium bismuthmate method is employed. In both cases the sample is brought into solution in nitric acid the same as is described for sulphur.

Seek a Permeability Standard Sand

The bureau of standards is conducting tests to discover a sand with 100 per cent permeability. The advantage of finding a perfectly permeable sand or one which approximates perfect permeability is obvious. Having a standard sand with a known permeability, the suitability of every molding sand could be expressed in percentage of a sand found to be 100 per cent permeable. To accomplish this result, several sands have been investigated. One commercial grade of sand, which is a pure silica sand of a fairly uniform degree of fineness, has been found on a number of tests, both dry and with as high as 4 per cent of moisture to be 100 per cent permeable. Further tests are being made to determine its colloidal matter or any other substances which might affect its permeability.

FIG. 10—CASTINGS MUST BE PREHEATED BEFORE BEING WELDED—STEEL IS WELDED ON SOME CASTINGS TO FORM A BEARING FOR THE CENTERING TOOL

Plans Test To Define Sands--II

Trials with Bars To Determine Transverse Strength Indicate the Size of the Bar as Well as the Method of Ramming the Sand and Introducing It Into the Mold Are Governing Factors

BY R. J. DOTY

THE results shown by the last set of tests described in the previous instalment of this article were not encouraging, but we believed the theory was right; so remembering our experience with the tensile tests, we constructed another box of the same size, but designed for ramming from both sides and from the top. This gave us a core 12 x 2 x 1-inch rammed from three sides. This box is shown in Fig. 7.

Table X shows that the results of tests on cores made in this box were more uniform than those obtained in previous tests, but they were not satisfactory.

In our manipulations of this box we encountered several mechanical difficulties which in our opinion had some effect on the results secured. To overcome these, a larger and more sturdy box was constructed, which permitted of several refinements, and which gave us a core of the same cross section, rammed in the same manner as the box just referred to.

When, after each test, we tabulated and studied the results, we seemed to note that the result obtained for the first break on each bar was in many cases the most divergent. We felt this was due to the way in which the sand fell against the end of the box during the filling operation. As we saw no way of overcoming this, we felt that at some later test we might have to discard the first break and consider only those from the center of the box. In the case of a strong sand which would permit of a longer overhang, this would greatly reduce the number of breaks per bar. As we were about to build a new box, it seemed advisable to provide for this, so decided to increase the length from 12 to 16 inches.

The results obtained by testing cores made in this box are shown in Table XI. This table shows the values were much more uniform than those obtained by any method so far tried. Further, a study of this table will indicate that various breaks on the same bar check one another closely, though the average of the various bars do not check as well. All the bars were made from the same sand, so we were led to believe that each bar was rammed uniformly throughout its length, but all the bars were not rammed alike.

In every case the box had been filled by forcing sand by hand through a ¼-inch riddle resting on top of the box. This practice had been adopted as the most logical way of introducing sand into the box. Our deductions based upon the fact pointed out by Table XI, made us realize in a concrete way that the sand could not have been introduced uniformly each time the box was filled.

In an attempt to eliminate such variation in filling, a riddle was constructed with dimensions corresponding to the opening in the box. To make sure that the riddled sand in filling the box would in every case fall through a given distance, suitable guides were provided and fastened securely to supports at each end. These guides also confined the motion of the riddle to travel in a straight line. Blocks at each end of the guides limited the motion to travel through a given distance. Rubber strips on these blocks eliminated severe shocks which might have caused the sand to settle in the box during the filling operation. This riddle is shown in Fig. 8.

To test this method, the corebox was placed under the riddle, which contained a number of stars, and filled to slightly overflowing. The excess sand was removed by striking off and ramming completed as in previous tests. Table XII gives the values obtained, and a

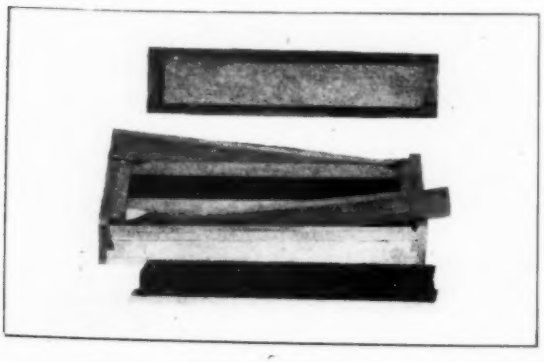
Table X

Transverse Tests—Rammed from Sides and Top

Bar	1	2	3	4	5	6
			Breaking Load—Grams			
Break 1	72.3	78.6	68.0	81.6	79.1	80.3
Break 2	67.5	64.1	72.3	76.1	78.4	81.2
Break 3	68.5	72.3	74.8	68.0	71.1	78.6
Break 4	72.3	67.5	70.8	72.3	79.4	79.0
Break 5	76.2	68.5	86.0	75.0	72.5	71.2
Average	71.36	70.20	74.38	74.60	76.10	78.06
	8.30	11.95	16.90	9.37	6.58	4.03

Maximum Deviation—Per Cent

Average Maximum Deviation	9.52 per cent
Grand Average Break	74.11 grams
Maximum Deviation	16.10 per cent



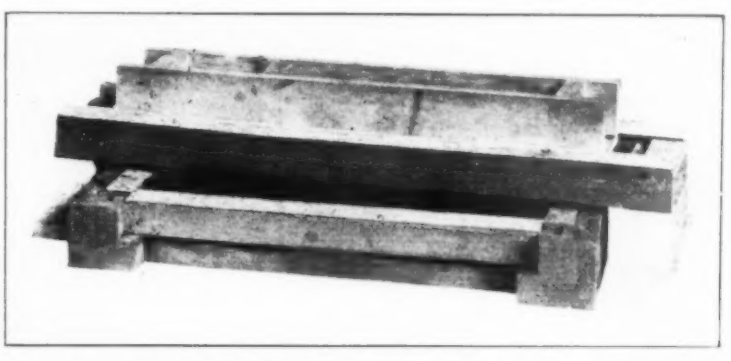


FIG. 7—COREBOX PERMITTING RAMMING FROM THE SIDE FIG. 8—RIDDLE USED IN FILLING COREBOX

closer uniformity than by any method so far tried.

In Table XIII we have compiled the average and maximum deviations of tests 1 to 12 inclusive taken from the tables already given, with statements indicating the manner of conducting each test.

Method Believed To Be Reliable

The results given by our last test showed up so well when compared with all previous tests that we believed the method to be reliable, but before adopting it, decided to try it out. To insure a real test, we proceeded as follows:

Ample samples of two different sands were placed in the humidor. Three trials were made of each sand. Each trial covered the making of three cores at one time, and then breaking them. For the reason already mentioned, it was decided to discard the first break so that each trial gave 12 breaks. Table XIV gives the results of these two tests.

Here we were testing two sands of different strengths, and in each case the result of 12 breaks from three bars checks with the results of 12 breaks from each of two other groups of three bars. The tests proved the method to be more reliable than we had hoped it could be.

We felt then that we had established a standard method for testing for green bonded strength which would be reliable and of value, for comparative purposes at least, over a long period. With this feeling of assurance, we started the mixing of experimental facings, and to our estimate of the values of the successive batches as regards green bonded strength was added the findings of the laboratory. These findings confirmed in figures what we could express only as an impression based upon our sense of feeling and our judgment. Then we produced batch after batch of facing, often repeating experiments and checking results to secure certainty. Whenever we increased the clay content of a batch, our senses told us the bond was greater; and the laboratory not only confirmed this, but in addition, gave us a figure representing that increase. For some time this situation continued to our extreme satisfaction, and then the unexpected happened.

We mixed a batch of facing which in our opinion was too dry, but the strongest we had made to date. The laboratory gave it the green bonded value of 247.7. We determined to duplicate this batch, raising the moisture content. The second batch felt stronger than the first, but the laboratory gave it a green bonded value of 119.06, less than half the strength of its mate.

Believing that some error had been made in the laboratory, and all the sand having been used, we duplicated the batch on the next day, but found the laboratory checked itself satisfactorily. To satisfy everyone, a recheck was made on the same sand, and with the same result.

Because the writer had every faith in the test itself and the manipulations connected with it, he looked first of all to the milling of the sand. Having personally mixed every batch, he knew that as the sands became stronger, the plows had acted as dams, decreasing the amount of sand under the muller.

Various adjustments of plows were tried, and increases were made in the milling period, but without changing the result as shown by the laboratory. Tests showed this mixture to be far weaker than those immediately preceding it, though its clay content had been increased 25 to 50 per cent over those batches, and our judgment estimated it to be stronger.

Results Show Paradox

Could the testing method be wrong? To check this out the plows were readjusted and a number of batches, duplicates of No. 1, were mixed until that adjustment was secured which with the original milling period gave sand of the same strength as the original No. 1. Thus we were evidently rigged up as at the start.

Our next move was to repeat each second batch and ascertain the green bonded strength. The values found checked unbelievably close to our original findings. This, in view of the sudden drop in our last batch, was hard to

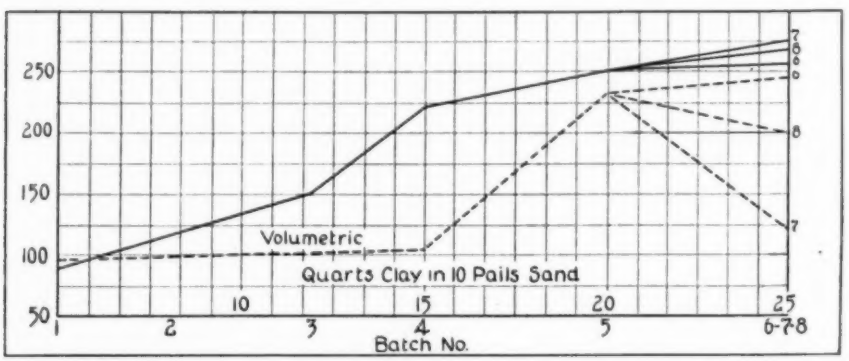


FIG. 9—GREEN BONDED STRENGTH PLOTTED AGAINST THE CLAY CONTENT OF EACH BATCH

Table XI

Transverse Tests—Bar Length Increased

Bar	1	2	3	4	5	6
			Breaking Load—Grams			
Break 1	105.0	103.0	95.3	110.0	87.7	105.0
Break 2	106.3	99.0	102.2	102.2	89.0	107.8
Break 3	100.0	89.3	97.7	89.7	87.6	97.6
Break 4	97.3	100.0	90.0	84.5	95.6	97.6
Break 5	102.5	109.0	95.6	96.4	97.5	99.6
Average	102.22	100.06	96.16	96.56	91.48	101.52
			Maximum Deviation—Per Cent			
	4.80	10.70	6.35	12.40	6.68	6.20

Average Maximum Deviation ..... 7.85 per cent
Grand Average Break ..... 98.0 grams
Maximum Deviation ..... 13.75 per cent

Table XII

Transverse Tests—Indicating Sand Not Uniform

Bar	1	2	3	4	5	6
			Breaking Load—Grams			
Break 1	109.3	108.6	112.1	116.9	110.0	112.5
Break 2	114.6	111.2	111.4	116.9	112.0	113.0
Break 3	115.6	123.2	120.9	121.0	127.0	116.1
Break 4	116.7	124.1	123.0	117.0	127.0	119.5
Break 5	128.5	124.0	122.6	124.0	126.3	117.0
Average	116.9	118.2	115.6	119.2	120.4	115.6
			Maximum Deviation—Per Cent			
	9.9	8.1	6.4	4.2	8.7	2.7

Average Maximum Deviation ..... 6.66 per cent
Grand Average Break ..... 117.6 grams
Maximum Deviation ..... 9.35 per cent

credit, so we duplicated every batch and again secured the green bonded strength. The values obtained again checked closely with our first findings.

The chart Fig. 9, shows the green bonded strength of the various mixtures platted against the clay content of each batch. The values we have been discussing are represented by the broken lines. In the batch at the extreme right there are three different values for green bonded strength. These values correspond to the different amounts of moisture content in those batches, the clay content being the same in each.

We stopped making experimental sand and tried to reason it out, we re-read our notes, we recalled and discussed all the phenomena we had noted during our work. In all of the experiments performed through batch No. 6, the laboratory results in every case had agreed with our observations. With an increase in the proportion of clay to sand an increase in the green bonded strength as determined in the laboratory always occured, though this increase in some cases was small and seemed to have no relation to the amount of clay present. Table 15 shows that in the first six batches an increase in the clay addition resulted in a stronger facing, and it also shows that this rule did not hold good in batch No. 7.

In making the various bond tests, various properties had been noticed about all of the test bars. Among them was the fact that the greater the proportion of clay or moisture, the more easily could the bar be rammed and with repeated increases in the clay, or moisture content, the test cores began to have a coarser texture and a seemingly greater proportion of voids. These properties became more noticeable with each succeeding batch until the bars from the seventh mixture, which contained a high percentage of clay and increased moisture, became so weak as to actually crush beneath the force necessary to move the bar across the plate. On the other hand, our sense of feeling and our judgment firmly established this sand as the strongest made thus far, an impression directly opposed to the laboratory finding of the low value of 119.6.

The redeeming fact in this situation was that good checks were secured on any one batch, proving the basic principle, of the method employed, not at fault.

Equal amounts of the same sand rammed to like condition should have the same bonded strength, equal amounts of different sands rammed to like condition should give results in accordance with the true properties of those sands. Evidently then batch No. 7 should have a higher bonded value than that determined by the laboratory.

The construction of our corebox was such that in each test we were compressing to the same final volume the same quantity of sand, measured volumetrically. From this statement it is apparent that we should have then in each cubic inch of each final bar the same amount of sand.

We have stated that an increase in clay content made the cores ram more easily and that an increasing openness of texture had been noted. This would seem to indicate that we could not be ramming the same amount of sand into the same final volume.

Our next move was to find if we were putting the same amount of sand into the corebox. Batches Nos. 1, 3, 5, 6 and 7 were duplicated and test cores were made from them by measuring the sand volumetrically as before. After ramming, the weight of each core was determined, and the results compared in Table XVI. An examination of this table will show the variation in the weights of the bars from the different batches.

An investigation then was undertaken to determine, if possible, the cause of this phenomenon. We believed that we were displacing some silica sand in each core when we increased the clay content of a batch. Could the clay be lighter than the sand, thus decreasing the weight of the bar? We accordingly dried some sand and clay and weighed each. We found the clay to be the heavier, which would indicate that the core should be heavier if one grain of clay displaced one grain of sand. Having arrived at this point, our next step was to determine the grain size of each. We found the clay to be finer, hence were led to believe that each grain of clay would not displace a grain of sand, for being finer, some of the clay would enter some of the voids between the grains of sand.

To determine to what extent the clay would fill the voids, or expressed differently, what would be the resulting volume of a mixture of equal volumes of sand and clay, we mixed thoroughly together, 1 quart of sand with 1 quart of clay. The resulting volume was 1.8 quarts. This would indicate that 10 per cent of the clay went into the voids.

From this we were led to believe that even should the clay be lighter than the sand, we should by increasing the clay content up to 10 per cent of the sand have a heavier core than we started with, for by filling the voids, we should have the additional weight of the clay. By weighing a quart of the mixture

TABLE XIV

Test No. 1—Sand *A*			Test No. 2—Sand *B*		
Trial 1	2	3	1	2	3
Transverse Breaking Load—Grams					
126.3	122.6	128.5	146.0	156.3	150.0
127.0	123.0	116.9	147.8	168.1	150.0
127.0	120.9	116.7	146.1	166.9	145.6
110.0	110.0	118.2	155.0	175.0	147.6
107.0	111.4	115.6	162.6	157.2	153.6
124.0	116.1	115.6	154.7	164.5	149.6
117.0	124.0	114.6	170.0	150.6	156.2
121.0	124.1	119.2	175.0	154.5	155.1
116.9	123.2	109.3	172.4	161.4	165.1
116.9	111.2	120.4	165.0	160.0	173.3
119.5	108.6	112.5	151.5	160.0	171.4
112.0	113.0	115.6	167.4	157.3	164.2
Average Breaking Load					
118.7	117.3	116.7	159.4	160.6	156.8

TABLE XV

Batch	Clay	Moisture	Green bonded strength
1	5	4.95	96.5
2	8	5.05	98.0
3	12	3.55	101.5
4	15	3.40	107.3
5	20	2.84	239.7
6	25	3.15	247.7
7	25	3.85	119.6

TABLE XVI

Batch	Clay	Moisture	Weight of bar
1	5	4.80	958.0
3	12	3.53	778.4
5	20	3.30	812.4
6	25	3.40	895.6
7	25	3.95	760.1

TABLE XVII

	Weight of one quart Grams	Grain size Inches
Silica sand	1240	0.01188
Fire clay	1270	0.01144
50 per cent silica sand and 50 per cent fire clay.	1405	0.01162

Table XIII

Summary of Tests in Tables I to XII

Table No.	Nature of Test	Method of Filling	Method of Ramming	Unit of Measurement	Remarks	Ave. Deviation Per Cent	Max. Deviation Per Cent
1	Transverse	Hand riddle	Top	centimeter		8.27	20.10
2	Transverse	Hand riddle	Top	grams		7.35	16.10
3	Tensile-horiz.	Hand riddle	Top	grams	Long core...	16.76	32.70
5	Tensile-horiz.	Hand riddle	Top	grams	Short core...	24.50	33.60
6	Tensile-vert.	Hand riddle	Top	grams/in²	Short core...	20.15	30.20
7	Tensile-vert.	Hand riddle	Top	grams/in²	Short core—3 moved from side	17.46	25.00
8	Tensile-vert.	Hand riddle	Top & side	grams/in²	Short core..	10.20	20.40
9	Transverse	Hand riddle	Top	grams	12-in. core...	10.11	27.50
12	Transverse	Sliding riddle	Top & side	grams	12-in. core...	9.52	16.10
10	Transverse	Hand riddle	Top & side	grams	16-in. core...	7.85	13.75
11	Transverse	Hand riddle	Top & side	grams	16-in. core...	6.66	9.35

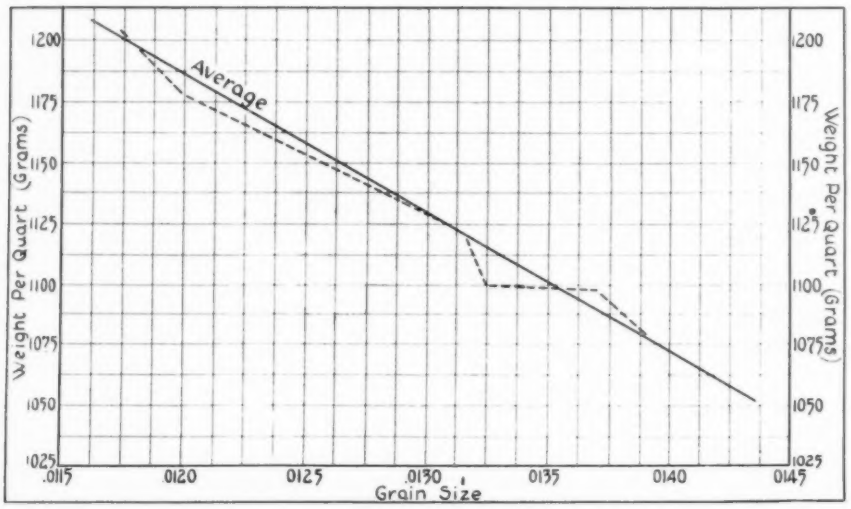


FIG. 10—EFFECT OF GRAIN SIZE UPON WEIGHT PER QUART OF FACING SAND

of equal volumes of sand and clay, we found this to be true.

A study of Table XVII will show that one quart of dried silica sand having a grain size of 0.01188 inch weighs 1240 grams; and one quart of fire clay having a grain size of 0.01144 inch weighs 1270 grams. When these materials were mixed in equal quantities in the dry state, the resulting mixture had a grain size of 0.01162 inch, and weighed 1405 grams per quart. This clearly shows that in a dry condition, clay fills in the voids of the sand, causing a finer and heavier mixture.

Having proved that the introduction of clay increased rather than decreased the weight of a given volume of sand, we were still confronted with the fact that an increase in clay content in the facing sand resulted in a loss of weight. We recognized at this point two factors which would have a decided influence on the problem.

In this test the addition of dry clay to dry sand resulted in a mixture whose grain size was less than that of the sand itself. In testing facing we have found that the addition of fire clay to sand increased the grain size. Since in both we used the same sand and clay, the only difference then could be through the moisture in the facing.

This would indicate clearly that when sand and clay are milled together in the presence of water, either the grains of sand become coated with a film of clay, or they pick up particles of clay. Either would increase the grain size in the same manner as a snowball is built up when rolled in snow.

You will agree that a decrease in weight of a given volume of sand and clay could not be brought about by the introduction of water, since water would enter the voids and increase the weight.

Having proved that manual additions of clay and water increase the weight of a specimen of given volume, we then had to consider the fact that these when added in a mill might have the opposite effect by building up the grain size, and perhaps increasing the voids.

To test this theory, batches Nos. 1 to 7 inclusive were duplicated, using the same sand and clay. Samples of these batches were dried and the weight per quart and grain size were determined. Table XVIII shows that in each case the mixture was coarser and lighter after drying than the original silica sand. Here we see that an increase in grain size brings a decrease in the weight of a given volume of sand. Consider that the measure in this test was filled with dry sand, reducing bridging to a minimum, and you will see that we felt we had the answer to our problem.

TABLE XVIII

Batch	Clay	Weight per quart	Grain size
1	5	1206	0.01172
2	8	1180	0.01200
3	12	1117	0.01319
4	15	1100	0.01325
5	20	1092	0.01373
7	25	1075	0.01394

All of our test cores were made of sand containing moisture. Add bridging of damp sand to increased grain size, and the result is that though we were placing in our corebox the same volume each time, we were not introducing the same amount of sand. This volume consisted of facing and of voids. With each addition of clay we were introducing a smaller volume of sand and a larger volume of voids.

In Fig. 10 we have plotted increase in grain size against decrease in weight. The result would indicate that the change is very consistent for the curve is practically a straight line.

If we are to approach the ideal condition of having for all tests the same total surface of non-bonding material upon which the bonded substances may act, it is evident that a volumetric measurement of quantity will not suffice. We have shown that the strong sands actually have less material per quart than the weak ones, and hence the bonding effect of a greater amount of clay was counterbalanced by the lesser degree of ramming.

The ideal method would be to count out the proper number of grains for each test, but this is impractical. The other alternative is to weigh the sample. In the gravemetric method, however, one precaution is necessary. A definite weight of a wet sand contains less actual sand substance than a mixture containing a lower percentage of moisture.

To guard against such an error we first evaporated the moisture from a part of our sample, and having ascertained the amount contained, increased the weight of the test specimen by that amount. It was found that 1000 grams of sand would produce a test bar of such density as to be statisfactory for all sands in which we were interested.

Our procedure then was as follows: The investigator secured from the mill a sample large enough to carry out all tests. This was put into the humidor. One hundred grams were taken for the moisture determination which, for example, was 3.5 per cent. In this case, for the green bonded strength test, we added 3.5 per cent, or 35 grams to the 1000 grams, which made the specimen weigh 1035 grams. If the moisture content had been 3 per cent we would have added 30 grams.

The corebox had been constructed so that the given volume of sand passed through the riddle (see Fig. 8) filled it level full. As increase in grain size results in a decrease in the weight of

Table XIX

Comparison of Bond Values

		Definite Volume		Definite Weight		
Batch	Clay Quarts	Moisture Per Cent	Bond Value Grams	Moisture Per Cent	Weight Taken Grams	Bond Value Grams
1	5	4.95	96.5	4.90	1050	88.5
2	8	5.05	98.0	4.71	1045	120.9
3	12	3.55	101.5	3.81	1040	152.3
4	15	3.40	107.3	3.35	1035	222.4
5	20	2.84	239.7	3.00	1030	252.6
7	25	3.85	119.6	3.50	1035	277.9

a given volume, it is apparent that a given weight of sand would, through increase in grain size, result in an increased volume.

It was necessary then to remodel the corebox to accommodate this increase in volume of sand. Our judgment indicated that by increasing the height by ¾ inch we would have ample capacity for any mixture. The new corebox therefore is 16 x 3 x 2 1/16 inches in height, producing a core after ramming 16 x 2 x 1 inches as in the previous experiment.

The weighed amount of sand is passed through the sliding riddle into the corebox. A riddle limited to one direction of motion will heap sand higher in the middle than at the ends, and to secure an even distribution in the box it is necessary to move excess sand in the middle to make up the shortage at the ends. Pressure applied during such an operation would pack the sand in the middle, resulting in a core which after ramming would be denser in the center than at the ends. To eliminate this possibility, a strike with a V shaped edge was provided and constructed so that it had to slide on the top of the box, preventing downward pressure. Since volumes of sand will vary, as already explained, a uniform distribution of material in the box is secured by passing a series of strikes, consecutively deeper by 1/16-inch, back and forth until the level of the sand is the same in all sections of the corebox. The sand is then rammed and tested as before.

The bond values of all preceding mixtures were determined, and a comparison of the old with the new values is made in Table XIX and the solid line in Fig. 9. The table and the graph show a vastly more probable set of results than those obtained by any other method, and it is our belief that this method approaches the ideal more closely than any method worked out so far. This method has been followed by the Sivyer Steel Casting Co. for several months, and nothing has happened to indicate that it will prove to be unreliable, as were its predecessors. The writer has believed for a long time that just as many defects may be traced to improper facing as to any other cause. By improper facing he does not necessarily mean faulty materials nor poorly balanced mixtures. The greatest difficulty is in the lack of uniformity from day to day or week to week. This lack of uniformity may be due to the variation in materials, the mills, or the operators.

Simple and reliable tests which check the facing will, if used consistently, warn of trouble to come before it actually develops. Most of us, if warned, are able to correct the exisiting condition.

Approve Safety Code for Foundries

ADEQUATE provision for the protection of industrial workers in the foundries in the iron, steel, zinc, lead, aluminum and other industries is included in the National Safety code for the protection of industrial workers in foundries which recently was approved by the American Engineering Standards committee. This is a revision of that developed by the American Foundrymen's association and National Founders' association, joint sponsors of the new code.

The approved code deals with foundry conditions only, omitting such subjects as building construction, exits, stairways, lighting, sanitation, etc., as these subjects are covered by other standards. A review of the history of this foundry code shows that this subject has been given consideration by foundrymen for many years. As long ago as 1911 Thos. D. West, one of the first men to advocate this work, in an address to the American Foundrymen's association assembled in convention at Pittsburgh, called especial attention to the need for accident prevention. Committees of men prominent in the foundry business worked out several codes which were submitted to American Foundrymen's association from time to time. About seventeen years ago the National Founders' association actively took up safety and sanitation in the foundry and for a space of over a year reports were received from their members covering about 15,000 accidents.

The committee which had this work in charge consisted of Magnus W. Alexander, chairman, safety director of the General Electric Co.; W. H. Barr, Lumen Bearing Co., Buffalo; C. A. Chase, Syracuse Chilled Plow Co., Syracuse, N. Y.; A. F. Corbin, Union Mfg. Co., New Britain, Conn.; W. S. Hallowell, Harrison Safety Boiler Works, Philadelphia; H. P. McDonald, Thos. Snead and Co., Iron Works, Jersey City, N. J.

Permanent Standards Sought

The work of establishing a permanent safety code was given impetus at the convention of the American Foundrymen's association held at Chicago in September, 1914, when a number of valuable papers on the subject of safety were presented. Among these papers were those by Magnus W. Alexander, A. W. Gregg, G. F. Kent, T. Morrel, Arthur T. Morrey, R. G. Williams and T. D. West. The following men were appointed as a committee on safety and sanitation:

Victor T. Noonan, industrial commissioner of Ohio; F. H. Elam, American Steel Foundries, Chicago; George B. Koch, Pennsylvania railroad, Altoona, Pa.; E. B. Morgan, Wooster, Mass.; Richard Moldenke, Watchung, N. J.; T. J. Soults, Sill Stove Works, Rochester, N. Y.; C. E. Pettibone, Pickands, Mather & Co., Cleveland; Ralph West, West Steel Castings Co., Cleveland.

This committee brought a report before the convention in 1916, which embraced a code which was discussed. The following year the committee presented a revised code which was formulated after discussion with the representatives of the National Founders' association. At this convention it was decided to defer action on the adoption of the code until a joint committee of the two associations could agree on its provisions. A conference of the joint committee resulted in a code being drawn up which after being submitted to the membership was adopted by both organizations. The joint committee was composed of the following members: For the American Foundrymen's association, B. D. Fuller, Ralph West and Earl Morgan, and for the National Founders' association W. H. Barr, A. F. Corbin, and H. J. Boggis, of the Taylor Boggis Co., Cleveland.

This code was the basis of the one which has been adopted by the American Engineering Standards committee, after the deliberations of their sectional committee, which included representatives of the American Foundrymen's association, the National Founders' association, the Association of Government Labor officials, the United States Department of Labor, the National Association of Mutual Casuality companies, the National Safety council, the United States Bureau of Standards, the National Association of Manufacturers, the National Bureau of Casualty and Surety Underwriters, the American Society of Safety Engineers and the United States Public Health Service. The code may be procured by addressing the American Foundrymen's association, 140 S. Dearborn street, Chicago or the National Founders' association, 29 S. La Salle street, Chicago.

European View of Malleable

Iron Oxide Principal Factor in Producing Poor Malleable—A Thoroughly Deoxidized Metal Will Run Well—French Triplexing Process Is Described and Results of Tests Are Given

BY T. LEVOZ

THE position of the malleable castings industry on the continent of Europe was considered at length at the joint French and Belgian foundry congress held at Liege. The following passages embody the principal opinions expressed:

The first aim should be to interest all our French, English and Belgian confreres in the institution of systematic experiments, which should all be carried out in a uniform manner so that they may be compared and the results intercommunicated.

Permanent intercourse also should be maintained with our American confreres, and steps should be taken to insure the regular exchange of communications between the various associations.

The second aim should be to interest the leading French, English and Belgian scientists in the investigation of the laws governing the manufacture of malleable iron, chiefly in regard to the effect of the silicon and of the sulphur, and on the condition of the carbon.

In this way we shall attain the position long ago reached by our American confreres; that is, we shall be able to compete successfully with cast steel both as regards quality and price, thus preventing the disappearance of an industry which was formerly flourishing but which is declining because European foundrymen work neither scientifically nor economically and are lacking in co-operation.

Before the war the average cost price of an American manufacturer of malleable iron turning out agricultural machinery castings was 25 centimes per kilogram, (about 2.4 cents per pound). Making all due allowances, there is no reason why we should not attain the same results.

Since then the Belgian and French technical foundry associations have met and decided to form a special commission for the purpose of carrying into effect the wishes expressed at Liege.

Shows Superior Strength

Special attention has been excited by the exceptional results obtained by American foundrymen as regards the quality of the metal which, it appears, ordinarily shows superior strength and elongation to that made by the European practice. A wide gap exists between the physical properties of malleable made by the two processes. To bridge this gap it is not enough merely to agree to establish uniform methods of experiment; what is required is an agreement to establish a single mode or method of production capable of supplying a metal suitable for the manufacture of good test pieces corresponding in structure to castings usually required in malleable iron.

What is a Suitable Metal?

I am considering here only the production of the metal, which is the starting point of all manufactured castings, for when the metal is suitable three-fourths of the work of successful casting has been done. What, then, is to be understood by *suitable* metal? In general foundry practice suitable metal is understood to be that which when cast flows over the sand in contact with it without attacking the organic matter. It is, of course, understood that the metal must combine the mechanical conditions and characteristics required. In order that the metal shall flow over the sand its iron oxides must previously be reduced, and if they are not reduced completely it is perferable that they should be in the ferric rather than the ferrous state.

Of course, apart from the question of pipes and shrinkages, a perfectly deoxidized metal may be cast at maximum temperatures without attacking the organic matter of the sands generally employed in foundries—for ordinary cast iron, malleable iron or cast steel. The error is chiefly noticeable among founders of cast steel, who often regard a dazzling metal as being too hot, even when it is greatly superoxidized, sometimes to the point of solidfying almost instantaneously when it is decanted into the ladle.

The purpose of these remarks is merely to point out to founders of malleable iron that their interest is not merely to study the part played by the carbon, silicon, manganese, sulphur and phosphorus, and that they have invariably neglected the part played by the principal factor—the iron oxide—which is the source of all their troubles and disappointments.

It is, in fact, the greater or less degree of oxidation of the iron that governs the temperature of the bath and, consequently, its composition.

Generally, whether it is a question of ordinary cast iron, of malleable iron or of cast steel, in which the oxidation of the iron plays the most important part, it is necessary to have the initial metal at the maximum temperature so as to facilitate all the reactions necessarily arising from the presence, in larger or smaller quantities, of the ferrous or ferric oxides.

Now the former absorbs heat calories in order to be reduced in presence of the carbon while the latter releases them. This is why it was stated earlier in the paper that it was preferable for the unreduced oxides in the metal to be in the ferric state.

It is easy to determine the presence of either of these oxides in liquid metal containing only iron and carbon, with aluminum or silicon and manganese.

Metal containing ferrous oxides boils violently in the presence of carbon and liberates graphitic carbon at the moment of solidification because all boiling causes cooling.

Examine the worn rails on the P. L. M. tracks; they are full of blisters flattened out at the rolling mills. These blisters contain graphite and unreduced ferrous oxides. This is a striking example of cooling produced by boiling; ferrous oxides and carbon.

Selection of the Furnace

To obviate this capital defect in the production of iron for malleable—a defect essentially of a practical nature—it is absolutely necessary that the first stage metal should be produced in apparatus providing maximum temperatures without the formation of ferrous oxides.

Foundrymen have available, the crucible which was the first system of manufacture employed. It requires mixtures of good quality, and as the materials composing these are not exempt from rust, ferrous oxides are developed dur-

Paper presented at the Rochester convention of the American Foundrymen's association through the courtesy of the Association Technic de Fondrie de France.

ing fusion. To remedy the bad effect so produced the temperature of the furnace must be increased. This causes an excessive consumption of coke or coal, the result of which is a prohibitive cost of production.

The cupola, which is mostly used, is the producer par excellence of ferrous oxides. It is a barbarous principle of fusion, especially for the production of iron for malleable castings. To be able to cast the metal at all suitably maximum temperatures must be obtained; the consumption of coke must be increased, as must also the silicon content. Hence the common practice of forcing the silicon addition to be able to make exceedingly thin castings.

The reverberatory furnace undoubtedly is the apparatus which least occasions the formation of ferrous oxides. However, it also is at the mercy of rusty materials and of other oxidizing tendencies. If the Americans employ it with success in producing malleable iron of great elongation and strength, this is because they have succeeded by practical methods in obviating the formation of ferrous oxides by effecting the fusion in a carbon oxide atmosphere. Unfortunately the employment of reverberatory furnaces is practicable only for mass production, and the consumption of malleable castings has developed less in Europe than in America.

If European foundrymen had at their disposal a cupola obviating oxidation of the iron it is evident that such an apparatus would be the ideal method of producing malleable iron, subject to the condition, however, that it should effect fusion at the highest possible temperature.

Four years ago, in the *Fonderie Moderne*, the writer drew attention in this connection to a small cupola with two tuyeres placed at different heights, with which he had obtained good results in a malleable iron foundry in Belgium.

Produces Oxidizing Flame

Fusion by gases is less to be recommended, because it is almost indispensable to produce oxidizing flames to secure the high temperatures required. In this connection it would be preferable to effect fusion by the pulverized (slack) coal system, provided regenerators capable of heating the air of combustion to over 600 degrees Cent. are employed.

This applies also to the use of heavy oils, and in this case it is also necessary and indispensable to have a furnace specially arranged for an adequate distribution of the heat without oxidizing the iron.

The converter and the electric furnace remain. The latter, when employed as a fusion apparatus, is at also the mercy of the pig iron, scrap or other rusty waste; the operation must be carried to the point of complete deoxidation, and even at this point it is difficult to obtain uniform carburization.

Recently the author made an experiment to see to what extent a metal fused electrically, obtained from highly oxidized scrap, and containing also 25 to 30 per cent of turnings agglomerated by the oxidation of the atmosphere, could be carburized and poured. Notwithstanding the fact that the slag was well composed and the temperature raised to the extreme limit, uniform carburization could not be obtained, and the metal, which appeared hot while in the furnace, solidified on being poured into the ladle because it still contained ferrous oxides which in spite of everything had not been reduced.

The only method of producing malleable iron electrically of uniform quality is by starting with scrap or a mixture of scrap and pig in a coke or coal-fired furnace. The metal thus obtained is poured into a closed electric furnace where it is finished, but for this purpose a powerful and cheap supply of electricity must be available. One foundry in the Hautes-Pyrenees, however, to which the writer is adviser, works on this system and obtains excellent results. It even provides foundrymen with pig iron produced by this method, which when remelted in cupola, crucibles or other furnaces, gives better results than blast furnace pig, because it contains a minimum of graphitic carbon and a minimum of sulphur.

In my opinion the only method of competing successfully with cast steel in Europe is to produce malleable iron on the same system as cast steel. The Germans, who have long specialized in the manufacture of cast steels and malleable iron, clearly recognized this, and since 1905 they have been making malleable by melting hematite pig in the cupola, afterward transferring it to the bessemer converter in a liquid state in order to desiliconize it and pour into the molds a metal which is merely carburized.

Three Germans introduced this method of manufacture into France with some success. This was at Colombier Fontaine, Doubs, about 1911. However, they did not succeed in competing against cast steel, which they were obliged to produce also to supply the requirements of their clients. This was because this process was far from perfect.

As a result of the sequestration of this establishment shortly after the declaration of war the writer leased the factory and was thus in a position to acquaint himself with the quality of the metal produced.

It was far from suitable for the uniform production of good malleable iron. A sample was taken from the numerous gates found in the works and analyzed, its composition being as follows:

	Per cent
Combined carbon	2.80
Graphite carbon	0.50
Manganese	0.30
Silicon	0.80
Sulphur	0.06
Phosphorus	0.09

The ordinary bottom-blown bessemer converter is not at all suitable for this kind of work, as it produces ferrous oxides while it is desiliconizing the metal. The result is that the white pig bath is obtained too cold, which causes the formation of graphitic carbon at the moment of solidification.

Process Unreliable

Without even trying this process, the writer decided not to employ it. In this he was well inspired for he found that the molders who had formerly worked with the Germans ran like hares to fill the molds placed at a maximum distance of 60 yards from the converters, although the metal was much too hot and fluid.

When asked the reason for this, they replied that when the Germans were there they were always made to hurry to cast the malleable iron, "otherwise they would not have produced a good casting." If from time to time a good casting was produced this was owing to the metal bath in the cupola having been overheated.

In 1915 the author started working scrap metal in the cupola, transferring it by means of a ladle suspended from the crane to a side-blown converter with D-shape section, which had been installed by the Germans for the manufacture of cast steel. According to the men who had worked with the Germans, the metal we were producing was much hotter and more fluid. It was no longer necessary for them to scurry to fill the molds. They found also that we turned out few spoiled castings, whereas the Germans used to have 20 to 30 per cent.

The composition of the metal delivered from the converter was as follows:

	Per cent
Combined carbon	2.340
Graphitic carbon	0.200
Manganese	0.440
Silicon	0.750
Sulphur	0.101
Phosphorus	0.082

The higher sulphur content was due to the quality of the coke used during the war. The Germans used coke which contained less than 10 per cent of ash and little or no sulphur. However, when the metal placed in the converter was too cold, or when, for any other reason, the desiliconization was accompanied by the formation of ferrous oxides, violent boiling took place as the metal flowed into the ladles, and the slag, which was ex-

tremely fluid, was carried into the molds along with the metal. It was then necessary to put a small addition of aluminum in the ladles to calm the bath and obviate blistering as much as possible.

Fractures of the reheated castings then showed a black structure similar to American castings. The castings were exceedingly malleable, and they bent even better than those having a granular structure. The mechanical tests of this metal gave a tensile strength of 35 kilograms per square millimeter (50,000 pounds per square inch) and an elongation of 5 per cent in 100 millimeters (3.9 inches). Its chemical composition was:

	Per cent
Combined carbon	0.100
Graphitic carbon	1.200
Manganese	0.330
Sulphur	0.101
Phosphorus	0.082
Silicon	0.987

The same metal without aluminum addition had a granular structure, from which it may be deduced that the presence of the aluminum for the purpose of reducing the ferrous oxides immediately before solidification favored the formation of hardening carbon or secondary graphite.

At this time it seemed that in order to obtain a more uniform metal, the metal from the converter ought to be passed into a furnace heated to 1500 degrees Cent., either by the gases, or by heavy oils or electricity, and that it ought to have a small admixture of metal taken from the cupola.

In 1915 the author registered a patent in France for this process, and it appears that about the same time W. G. Kranz took out a similar patent in America for a "triplex process for making electric furnace malleable castings." The writer subsequently recognized that it was undesirable to reintroduce metal produced by the cupola, which favors the formation of graphite at the moment of solidification. The converter was installed with cylindrical crucible and tuyeres arranged tangentially to a circle of fixed diameter. A hotter and more liquid metal was obtained, because ferric oxides were formed at the surface of the metal bath and there stimulated the desiliconization and, to a certain extent, the decarburization, while maintaining the bath at the necessary temperature for casting without any aluminum addition.

When the operation is carried out normally in this converter the reddish vapors surrounding the flame do not appear until after desiliconization and at the beginning of decarburization, increasing in proportion as the latter advances. The vapor ought not to cease on the first break through of the flame; it ought to continue until the second break and issue abundantly at the end of the blow.

If the reddish vapor is plentiful at the outset of the operation and diminishes or ceases on the first break through of the flame, ending with a rather bluish vapor, this indicates that the operation has not been effected normally.

In the first case, the adjustment for obtaining the malleable iron has been well determined, while in the second case it has been faulty, the result being variations in the quality of the metal. It then occurred to the writer to pass this metal, still taken in a very hot and fluid state, into a furnace heated to 1550 degrees Cent., either by the gases, heavy oils or pulverized coal, but preferably by electricity, merely for the purpose of deoxidizing, desulphurizing and regularizing the carbon, silicon and manganese contents.

Under the blowing conditions in the first case there is formation of ferric oxides which obviate the ebullitions which are so detrimental to obtaining suitable metal, and under these conditions the operation of adjustment in the furnace is easily effected.

In the second case ferrous oxides are formed, causing ebullitions and rendering the final operation of the furnace more complicated. It is necessary to overheat the metal bath in order to bring about a really effective reduction.

It was after coming to these conclusions that the author finally took out a French patent on this method of manufacture. An English patent also has been granted.

In order to work this triplex process accurately and obtain the metal desired it is essential that the following apparatus should be employed:

A cupola with combustion zone distinctly separated from the zone of fusion in which only reducing gases circulate;

A side-blown converter which evacuates the slag as fast as it is formed, insuring the formation of ferric oxides which secure the fluidity of the metal for the purpose of preventing the formation of graphitic carbon on solidification;

An electric furnace which insures the proper distribution of heat with a minimum expenditure of electric power; or a heavy-oil furnace, if electric power is not available.

The average composition of the metal obtained is as follows:

	Per cent
Combined carbon	2.30
Graphitic carbon	traces
Manganese	0.30
Silicon	0.40
Sulphur	0.03
Phosphorus	0.05

This metal, being obtained very hot and freed from oxides, flows over the sand and produces castings which look clean and are without the defects usually found in ordinary malleable castings.

It is noteworthy that castings of the most complicated form may be left to cool in the molds with little risk of dents, cracks, flaws, fractures or other defects. The constant use of a reheating furnace, always alight to take the castings which are still red when stripped, is thus obviated.

No distinction is made in the silicon content whether thick or thin castings are made, which enables a metal only slightly charged with graphitic carbon to be obtained; and in view of the absence of oxides the latter is distributed uniformly throughout the mass in a pulverulent state, preventing the formation of cavities which cause breakages of continuity and are destructive of elongation and resistance.

Will Hold Meeting in Birmingham

Through the secretary of the British cast iron research association it is announced that another international exhibition of foundry and shop equipment will be held at Birmingham, England, under the auspices of the Birmingham chamber of commerce in the early summer of 1924. It will be the second foundry exhibition in Great Britain; the first, which was unusually successful, was held last June. Steps will be taken to insure a greater international representation at the 1924 exhibition and arrangements will be made to extend the number and variety of foundry employes' competitions which were a prominent subsidiary feature of the Birmingham show.

Welding Company Moves Western Branch

The Oxweld Acetylene Co., Newark, N. J., recently has removed its western department, formerly located at 1077 Mission street, San Francisco, to 1050 Mission street. Leo Romney, manager of the western department, states that the move to new quarters in San Francisco was made necessary by the rapidly growing business on the Pacific Coast.

Painting Conserves Heat

J. W. Richards, professor of metallurgy, Lehigh university, Bethlehem, Pa., in a communication to the American Electrochemical society advocates that electric furnaces be painted as this will lower the power required by about 10 per cent.

BuildsNewWestCoastFoundry

Requirements of Castings Trade Along the Pacific Demand Facilities to Handle Varied Work—Large Propeller Made in Cores Cited as Example of Practice

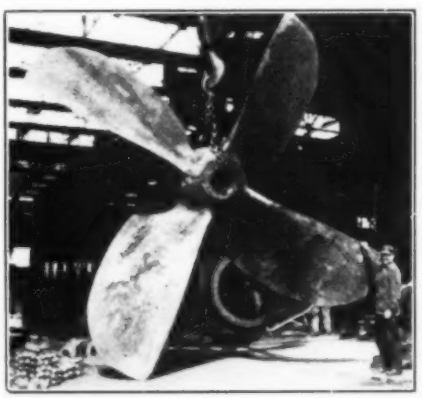
BY DON PARTRIDGE

DUE to certain fundamental and underlying factors, foundry operations on the Pacific Coast are confined with one or two exceptions, to those of the jobbing variety. The demand for castings, of any one particular kind or size has not been, up to the present time, of sufficient volume to absorb the output of a modern production plant. This is not surprising when it is realized that according to the 1910 census the combined population of the three coast states, Oregon, Washington and California, is only 4,192,214 or about half of that of the city of New York.

Because of excessive freight rates, western manufacturers in nearly every instance are unable to find an outlet for their product in the eastern markets, and this has further retarded the establishing of production plants on the coast. Difficulty also is experienced in obtaining raw material, which, in the case of foundry operations, either must be imported from foreign countries or shipped several thousand miles from eastern iron and coke manufacturing centers. Practically the only production plants on the coast are the Griffin Wheel Co., Los Angeles, the American Brakeshoe & Foundry Co., Los Angeles and San Francisco and the Union Tool Co. at Torrance, Cal., and several small piston ring foundries. However, to take care of the miscellaneous demand for castings in small lots, many of the coast foundries are installed in modern plants provided with the latest equipment.

Wide Range Possible

One of the largest, and best equipped foundries west of Omaha, is the one recently erected on the 10-acre plant site of the Llewellyn Iron Works in Los Angeles. It is claimed that this plant is prepared and equipped to handle any weight or class of iron and steel castings from those weighing but a few ounces to the largest used on the Pacific Coast.



The foundry building in insurance terms is a class *A* structure, fire-proof and composed of steel, brick and concrete 180 feet wide and 370 feet long. It consists of a main bay 75 feet wide and two side bays approximately 50 feet wide. The main bay is served by a 60-ton Llewellyn electric traveling crane with a 15-ton auxiliary hoist. The runway extends 75 feet beyond the end wall of the side bays as shown in Fig. 7. This arrangement permits the crane to pick up a heavy casting anywhere on the main foundry floor and load it directly onto cars for shipment. In addition to the 60-ton crane, two 15-ton Llewellyn cranes mounted on tracks on a lower level, serve the main bay. The runway for these smaller cranes extends 150 feet beyond the end walls of the main building and facilitates handling the flasks and other material direct to and from storage and the foundry floor. Practically all the cranes used in the foundry were designed by the Llewellyn Iron Works and constructed in its own general structural department.

In addition to the windows, light and

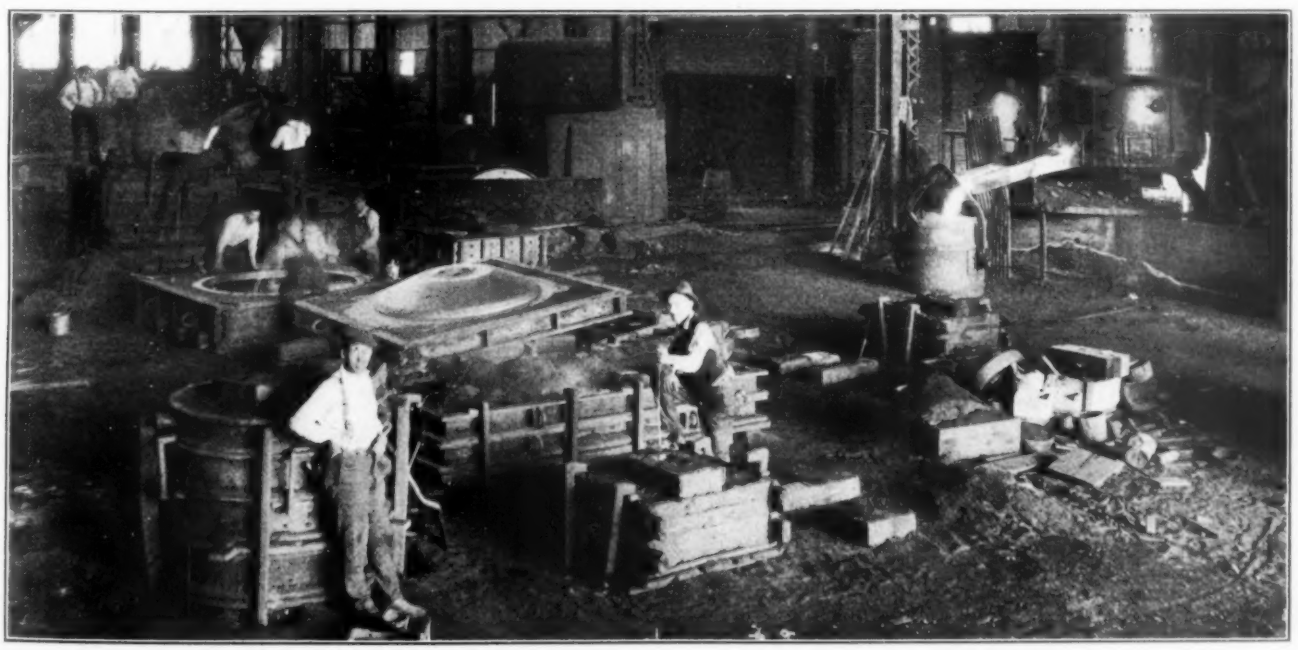


FIG. 1—DRAG SIDE OF THE WHEEL AS IT APPEARED AFTER LEAVING THE MOLD OF THE FOUNDRY

FIG. 2—GENERAL VIEW IN MAIN BAY

FIG. 3—THE CORE OVEN CAR RUNS ON FOUR TRACKS AND IS PULLED IN AND OUT OF THE OVEN BY A CABLE OPERATED BY AN AIR MOTOR FIG. 4—THE CRANES ARE MOUNTED ON UPPER AND LOWER RUNWAYS—SAND IS DISTRIBUTED BY THE GRAB BUCKET SHOWN IN THE CENTER FOREGROUND

ventilation are secured through a saw tooth roof with a vertical height of 10 feet and a gradual pitch. The vertical portion is composed almost entirely of glass and the pitch of galvanized, corrugated sheet metal. The peak of the saw point is 65 feet from the ground. The opposite end of the main bay from that shown in Fig. 7, is constructed of glass about two-thirds of the way down from the roof. The wall of one side bay contains no glass windows but is provided with numerous ventilators and side doors. Glass windows form part of the wall in the side bay containing the cupolas but the remainder has only the ventilators and doors as in the opposite side bay.

Arrangements for future extensions were made at the time of construction and it will be noted in Fig. 7, that the saw tooth construction of the roof is carried out part way but this portion of the structure has not yet been roofed or sided. It is planned to complete this section in the near future.

The side bay not shown in the illustration is served with two 5-ton Llewellyn cranes which travel the entire length of the building. They are equipped with button control boxes operated from the floor by any person thus saving the expense of cranemen. The opposite side bay shown in Fig. 8 contains the cupolas, core ovens and core room, the latter served by a 15-ton Llewellyn traveling crane which is controlled from the floor in the same manner as those of the opposite bay.

Supplementing the crane service an industrial railway and turntable system has been installed connecting the main and side bays at several intersections.

Core Room Facilities Large

The core room shown in Fig. 8 is exceptionally large and contains two car type core ovens and one small shelf oven equipped with shutter type steel rolling doors and heated with gas under forced draft. The core oven cars are exceptionally wide and are supported by wheels on two sets of tracks as shown in Fig. 3. The two inner wheel trucks are not shown in the picture as they are centered in the middle of the car. The car is pulled in and out of the oven by a pneumatic motor which operates a drum carrying a cable attached to the center of the car end.

Molding sand is transferred from place to place by a large grab bucket shown in Fig. 3 worked from one of the cranes. Several gyrating riddles made by the Great Western Mfg. Co., Leavenworth, Kan. are provided for riddling the sand.

Three cupolas together with all the auxiliary equipment supplied by the Whiting Corp., Harvey, Ill., have been installed for melting the iron. Two have a shell diameter of 78 inches and an inner lining diameter of 64 inches. the other one has a shell diameter of 60 inches and an inner lining diameter of 48 inches. All materials for the charge are loaded into industrial railway push cars, weighed and then lifted by an elevator to the charging floor, where storage room for many cars has been provided on a series of parallel tracks. Cars from this storage space can be shifted over to the dumping platform by means of a cross-carriage which operates in a transfer pit as shown in Fig. 5.

The contents of the charging car are dumped into the cupola by a small air hoist suspended from one of the roof beams shown in Fig. 5. The cars are held on the platform by a quick action clamp. The coke cars are equipped with loose sides hinged at the top and latched at the bottom, but the iron cars are open at both sides. Blast for the cupolas is supplied by two electrically driven

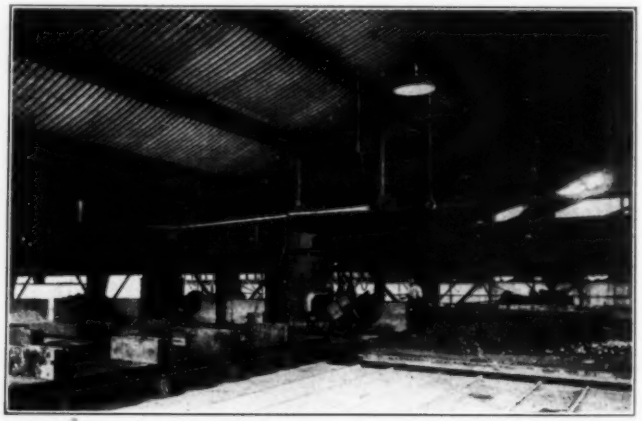


FIG. 5—INDEPENDENT MOTOR DRIVEN BLOWERS FOR EACH CUPOLA ARE MOUNTED ON A MEZZANINE FLOOR DIRECTLY BACK OF THE CUPOLAS FIG. 6—THE CHARGING FLOOR IS AMPLE IN AREA TO SERVE THREE CUPOLAS—THE THIRD CUPOLA TO THE EXTREME RIGHT OF THE PLATFORM IS NOT SHOWN IN THE ILLUSTRATION

MICROSCOPY OF CAST IRON

(*Continued from Data Sheet No.* 460)

Correct exposure varies with the light source, ray filters used, size of light pencil admitted to microscope, magnification and bellows length, and with the kind of plate or film used. The best way to determine the correct exposure is to make a series of exposures on one plate or film. First remove opaque screen from holder and expose, let us say, 2 seconds without, or about 8 seconds with ray filter. Then push the screen in an inch and expose another interval. Continue this until the screen is completely inserted, keeping notes as to time for each exposure. Development will show which strip had the proper length of time and this length of time should be used for other photographs taken under similar conditions.

Although ray filters increase the exposure time they add to the contrast and increase the resolving power. Most pictures should be taken using ray filters. The yellow, green and blue are most useful.

While plates are generally used for photomicrographic work the author has found films fully as satisfactory for all classes of work and better than plates to handle and file. After experimenting with a number of grades of films the laboratory of the Niles Tool Works Co. has standardized two for its use. The one gets the details satisfactorily, has good contrast and sufficient color value for metallographic work; the other is used where extreme contrast is the main object.

*Preparing the Photographs**

The darkroom should be of sufficient size, light proof, and well ventilated. It should have electricity and running water.

The apparatus needed consists of a developing tank, four rubber trays; a fixing box; a zinc washing box; darkroom lamps; a printing box; film hangers; and a fixture for film hangers. The microscopist is fortunate if his company maintains a photographic department. It does not take long to show the photo-

*Prepared by James Cooley, photographer for the laboratory of the Niles Tool Works Co., Hamilton, O.

(*Continued on Data Sheet No.* 462)

MICROSCOPY OF CAST IRON

(*Continued from Data Sheet No.* 461)

grapher what is wanted, and much trouble and expense is saved. Individual care is needed in preparing photomicrographic films and prints. For this reason it is not advisable to send work to a commercial photographer.

Directions for solutions used in preparing films and prints are enclosed in each package. To develop a film, or plate, remove it from holder and place it in a developing holder by means of a fixture. Place it in the developing tank, moving it up and down to remove any air bubbles. If ortho or other color sensitive plate or film is used, handling the film and development must be done in total darkness, or with a safety lamp. The operator should see a faint image in about 30 seconds. Development should be carried until nearly complete; that is, until no more development will take place and, of course, before any fog appears. This takes about 6 minutes for work at about 65 degrees Fahr. The film is then washed a few moments in running water and placed in the fix box. Fixing takes about 15 minutes. The film is washed for 10 minutes in running water, then hung up until dry.

Best printing results are generally obtained with rather thick films with sharp contrast and good detail. Slow contrasty papers with glossy finish give best results. Experience in printing will enable the operator to overcome many faults in the films. Knowledge of how to get results in printing is almost as valuable to the operator as the knowledge of how to take the pictures. Unfortunately no real short cut is open to supplant experience in the art. The finished pictures should have a sharp contrasty appearance, with the significant structures clearly outlined. The field should appear flat and the lighting even. Prints should be numbered and kept in a key book. Films are numbered correspondingly and kept in a large card file index. Data on samples, according to the number of the print and film, are kept in a separate notebook. In this way the microscopist has his work in permanent form and kept conveniently for ready reference.

The preparation of slides for projection and of enlargements for illustrations open an interesting field to the advertiser, the instructor, and the speaker. Films may be used satisfactorily for preparing slides and for making enlargements.

(*Continued on Data Sheet No.* 463)

THE FOUNDRY DATA SHEET, JANUARY 15, 1923
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

blowers supplied by P. H. & F. M. Roots Co., Connersville, Ind.

The yard is served by three locomotive cranes, two of which are steam driven but may be operated electrically by attaching a cord and plug to any outlet of the extensive system of underground cables, through which current is supplied from a central power station. The other locomotive crane especially designed by the Llewellyn Iron Works is operated either by gas or electric current. When stationary it is operated by plugging into one of the outlets of the underground system and before moving on and also before removing the plug connection, the gas motor is cranked which generates the current necessary to move the crane to the next outlet. Pig iron and scrap are handled by magnets attached to all of these locomotive cranes. Compressed air for pneumatic tools, portable and stationary is available practically all over the plant at outlets which are strategically located.

Operate Brass Foundry

A brass foundry is operated in part of one of the side bays, and in addition, steel castings are turned out at a second plant of the company located at Torrance, California. This plant embraces the open-hearth and rolling mill departments. Steel for the castings is produced in a large Heroult electric furnace.

The 18-foot propeller shown in Fig. 1, presents an interesting example of how some of the jobs are handled in the iron foundry. Three of these 4-blade wheels, each weighing 24,500 pounds, were cast in one mold. The mold probably would have served for several additional wheels, but three wheels completed the order and the mold was required no longer. Briefly it may be stated that an individual core was made for the drag side of each blade. A corresponding core was made for the cope side and when all these cores were assembled in their proper relative position they formed a complete mold in which the wheel was cast.

The only special rigging required consisted of eight arbors cast in open sand molds, one for each core, four core plates also cast in open sand molds and one cast iron corebox. A strong sand match was made off the cope side of the blade and baked in the oven. After it was dried it was placed face up on a plate and the pattern was adjusted in place. The iron core-box was assembled around the pattern, rammed full of sand, rolled over and the match was removed and employed in a similar manner until all four drag cores were made. After the match was removed in each case a cope was rammed on top of the drag half in the same manner that any cope is rammed. After the cope core was rammed the corebox was removed and the cope core was lifted and placed on suitable stands on the core oven car. Two cope cores and two drag cores were made and dried and then placed on the foundry uoor, thus releasing the plates for the remaining two pairs of cores.

When the complete set of cores was ready the four drag cores were adjusted in their proper position by the aid of a spindle. The cope cores then were set on, the hub was made up and the mold secured ready for pouring in the usual manner. With this outfit the three propellers were cast in one week. However, the elapsed time for the three wheels amounted to three weeks since two weeks were consumed in preliminary work before the first wheel was ready to be poured.

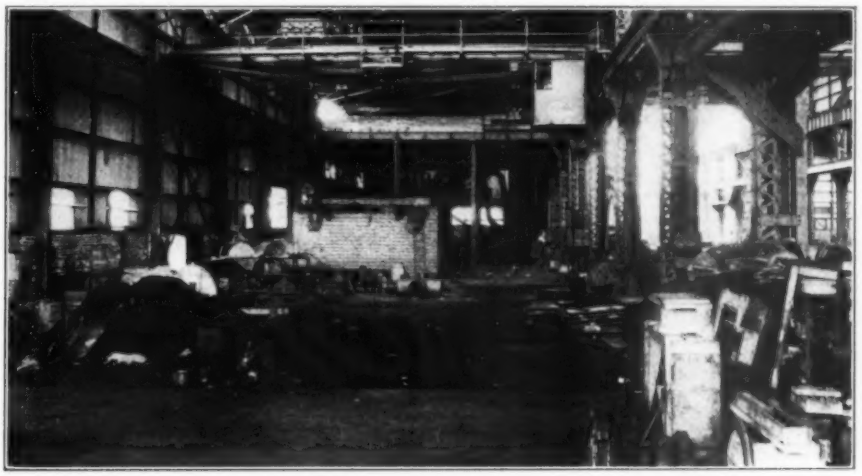


FIG. 8—THE CORE ROOM LOCATED IN THE SAME BAY AS THE CUPOLAS IS PROVIDED WITH A 15-TON CRANE

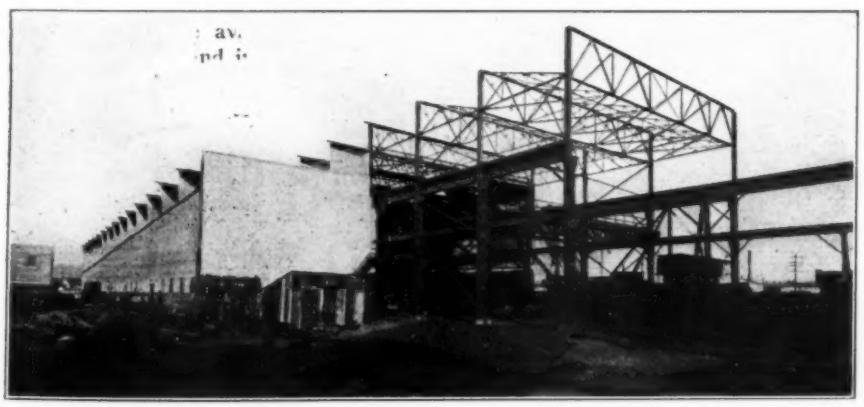


FIG. 7—EXTERIOR VIEW OF THE FOUNDRY SHOWING SAW TOOTH ROOF CONSTRUCTION ALSO UPPER AND LOWER CRANE RUNWAYS ON THE EXTENSION

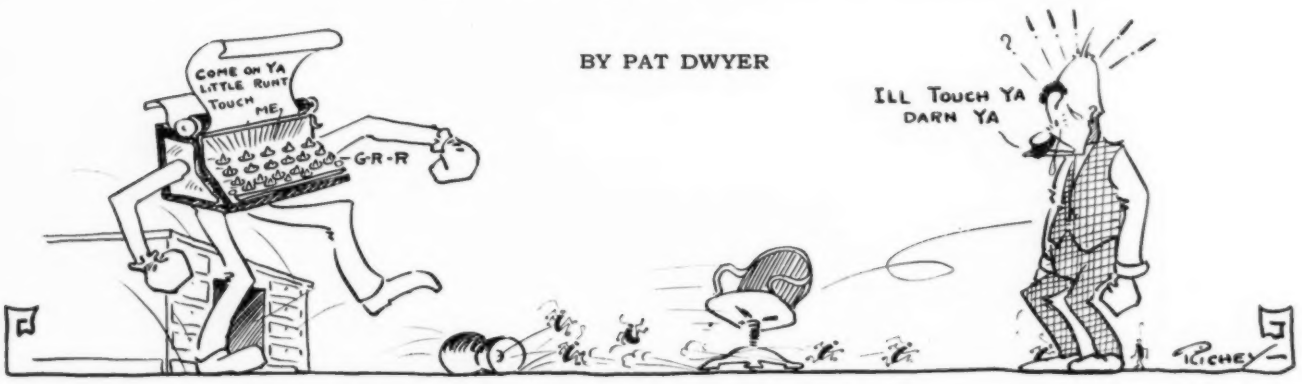
Studies Chromium Nickel Pig Iron Effects

The paper on the effect of nickel and chromium on cast iron, presented by Richard Moldenke at the San Francisco meeting of the American Institute of Mining and Mechanical Engineers, has been published as a pamphlet by the Bethlehem Steel Co., Bethlehem, Pa. This gives the results of several hundred tests made by melting charges of pig iron and scrap in crucibles and varying the proportions of the chromium-nickel pig iron made by the Bethlehem company. Conclusions are drawn as to the effect of the chromium-nickel pig iron on the transverse and tensile strength and on the hardness as shown by the brinell test. Dr. Moldenke is making further tests with this metal and is studying the structure by the aid of micrographs, the results to be published later.

The Gibb Instrument Co., Bay City, Mich., has taken over, under exclusive license, the manufacture and sale of the automatic and semiautomatic electric arc welding machines developed and heretofore manufactured by the Fred Pabst Co., Milwaukee, and have contracted to act as selling agent for the patented covered electrodes made by the Pabst company.

Bill on Repairing Broken Castings-I

BY PAT DWYER



IN YOUR own experience you probably have noticed that the most difficult feature connected with writing lies in the selection of the first word and in the construction of the first sentence. The sensation is somewhat similar to that of taking your first plunge after the swimming season opens. You approach the water gallantly with your mind firmly made up to walk out to the end of the springboard and then dive head first into the cool, inviting green water. When you arrive at the tip of the springboard you are seized with a sudden misgiving that perhaps the water is not quite as warm as it might be. You recall all the stories you ever heard of people who either through choice or through force of circumstances jumped into ice cold water and as a result developed cramps which caused them to drown right before their horror stricken and helpless friends.

You decide that the sensible thing to do is to test the temperature of the water before committing your precious body to its embrace and to that end you walk back gingerly to a point where you can lower one foot cautiously and wet the ends of your toes. The contact usually produces a violent eruption of goose pimples extending from your toe nails to the roots of your hair and convinces you that the water is at least 14 degrees below zero. You begin to wonder if a violent geographical disturbance has occurred resulting in the waters from the Arctic ocean rushing in during the preceding night. You would not be in the least surprised to find an iceberg bobbing up serenely and maybe a polar bear or two come snooping around a corner to stare in your face.

About this time the remainder of your gang is in the water, shouting and splashing and you are torn between the opposite emotions of pride and fear; the everlasting conflict between the flesh and the spirit. The spirit cries loudly to take a running jump off the end of the dock and the cowardly flesh clamors just as insistently to give up the silly notion and to once more get inside all your clothes. Pride, or its equivalent, fear of ridicule, usually conquers. With a mental malediction on the head of the man who first invented swimming you creep shivering out to the end of the springboard and then with gritted teeth and a sinking sensation in the region usually occupied by your stomach, you jump. By the time you come to the surface and find your legs and arms working automatically you discover that the water is just about the proper temperature for thorough enjoyment.

As I said in the beginning, the first written word and sentence are the hardest. After a start has been made, the remainder parallels the experience of the timid swimmer who hesitates to take the first dip. For example I sat down quite cheerfully before my little typewriter with my mind fully made up, as I thought, to dash off a few pages covering Bill's observations on the subject of repairing castings in the foundry. The preliminary motions, filling and lighting the pipe, slipping the first sheet into place, and writing the title were purely automatic and presented no difficulty, but when I poised my trusty index finger above the key board and contemplated all the characters staring me in the face, the 26 letters of the alphabet, the 10 numerals, all the punctuation marks and in addition the various symbols from the ($) to the (*), I felt utterly at a loss which one to hit first. I smoked out one pipeful without coming to a decision and then actuated by the same impulse that prompts the swimmer to take a long running jump off the end of the dock I pressed down the first character on the key board with the following result:

About a week ago Bill came in to see me and to show me a couple of new teeth which an obliging dentist had anchored in his lower jaw. I commented favorably on his improved appearance and also on the ingenuity displayed by modern dentists not only in filling cavities in the teeth, but in creating cavities in the victim's pocketbook. "I won't deny" said Bill "that the dentist is a handy lad, but you must not forget that he has quite an assortment of delicate, accurate and I might say sensitive instruments to assist him in performing his operations and in turning out his product. Furthermore, if he does a repair job for you he can take his time and if necessary can invite you back to his little chamber of horrors several times to afford him an opportunity of making minor adjustments. Contrast that with

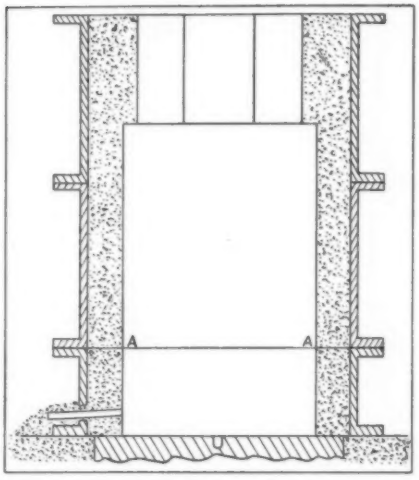
LAUGH AND THE WORLD LAUGHS AT YOU

the conditions obtaining in the ordinary foundry and you must admit that the molder is deserving of more credit than he usually receives. What I have in mind particularly is where he tackles one of those jobs known in foundry parlance as *burning-on*.

"The dentist can fiddle and excavate and drill around the inside of your face as long as he pleases and then if the repair parts do not fit he can make adjustments here and there until the job is fit to pass the inspector. The molder attempting to burn a new neck or wabbler on the end of a broken roll has one chance. If he wins, the casting is salvaged from the scrap pile. If his calculations go astray the casting is in worse condition than when he started. Whether the job is to be classed as an asset or a liability is determined in the relatively few seconds required to pour a ladle of iron.

"The broken end of the roll is machined true and at right angles to the working face. The job could be done with a sledge hammer and cutter and in fact would have to be done in that manner where no other equipment is available, but usually machine tools are in the vicinity where rolls are made and used, and therefore a lathe usually is employed for the purpose outlined. After the end is faced, a dowel hole is drilled in the center to locate the neck pattern. Usually the hole is drilled before the casting leaves the machine shop, but if not, it is no trouble to connect an air drill to the air line present in nearly all modern foundries. Failing an air line, electric drills are available to a considerable extent and if neither of these drills can be had, there always is the old reliable hand ratchet braced from an *old man*. The dowel hole is not an actual necessity, but it is quite a convenience.

"The machined surface on the end of the roll serves the double purpose of presenting a clean surface for the reception of the molten iron and also as a guide for setting the neck pattern accurately. A freshly cut surface will *take* the iron more readily than one that forms the natural outside face of a casting. This is due to the fact that the skin of practically all castings is harder than the metal on the inside. Usually an attempt to repair the casting is made while the break is fresh and in some cases it is not necessary further to prepare the surface in any manner. In other cases where the break is of long standing and the surface has become oxidized to some extent, if not actually rusted, it is necessary to remove the film before pouring molten iron over it. Rust when brought into contact with molten iron will produce a more violent explosion than water under the same circumstances.



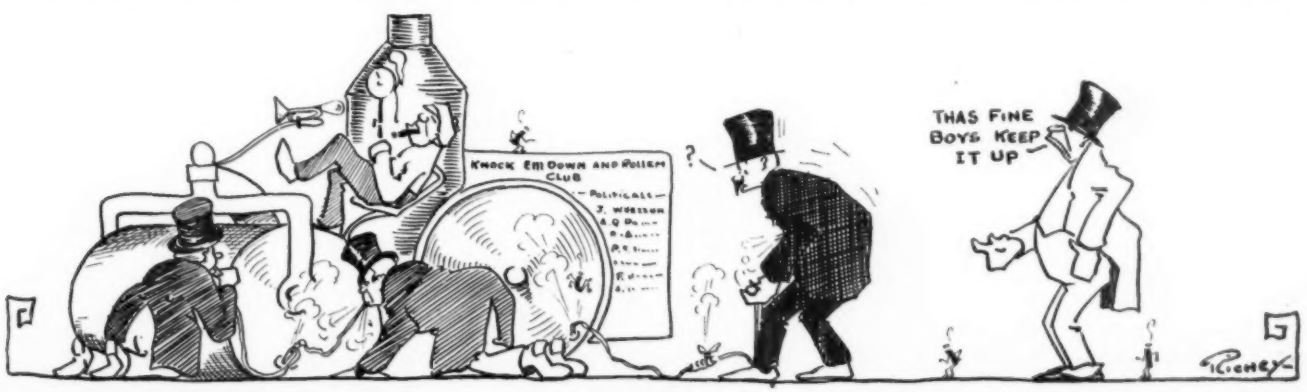
SECTION OF ASSEMBLED MOLD—THE LOWER SECTION IS FILLED WITH IRON UP TO THE LINE *A A* BEFORE THE REMAINDER OF THE MOLD IS SET ON

"The most convenient position in which to repair a broken roll is while it is supported upright in a hole in the floor with the exposed end approximately flush with the floor level. Occasionally it may be necessary to raise it a few inches above the floor, either for convenience in pouring or to afford clearance for the stream of overflow metal. However, this merely is a detail depending on local conditions and the size of the roll and does not affect the general mode of procedure.

"Sand is rammed around the casting until the hole is filled. Due care is observed during the ramming process to see that the casting is not deflected from its perfectly plumb position. A slight deflection would not seriously interfere with the success of the process, but if a job is worth doing it is worth doing properly and therefore the prepared surface should be kept level.

"After the sand has been rammed flush with the upper surface of the casting, a level parting is made all around large enough to accommodate an iron flask about 6 inches deep and large enough in diameter to provide 2 or 3 inches of sand between the casting and the wall of the flask. If a wood flask is employed it should be a little wider. The height of the first section of the flask is not held arbitrarily to 6 inches. It may be more, but it cannot well be much less. It is designed to form a well or reservoir that will hold the molten iron in a liquid condition during the few seconds required to assemble the remaining part of the mold in position. A shallower body than 6 inches will cool rapidly, while on the other hand if the flask is deeper than 6 inches the walls of the mold will interfere with the stream of iron as it falls from the lip of the ladle.

"The flask section is provided with an opening through which the overflow iron may escape while the operation is in progress. The height of the opening, that is the distance from the bottom, will vary to some extent depending on the area of the surface to be treated. Usually about 2 inches will be found satisfactory. A layer of metal 2 inches thick and constantly replenished will remain liquid indefinitely and at the same time it is not too thick to prevent the hot metal from the ladle reaching the bottom and acting on the surface of the casting.



ALTHOUGH NOT OFFICIALLY LISTED AS A WEAPON OF OFFENSE AND DEFENSE THE STEAM ROLLER HAS MERITS

Under certain conditions it is perfectly feasible to construct an overflow channel flush with the surface of the casting. If the opening is made quite small the stream from the ladle may be regulated to maintain any desired height of metal above the face of the casting. Thus by pouring a larger stream than the overflow can take away, the level will be raised, while if the stream is slackened the overflow rapidly will lower the level of the iron in the mold surrounding the surface to be repaired.

"Assuming that the flask has been set on the parting, the neck pattern is located by the dowel pin, or failing in that, in some other suitable manner. A gate pin is inserted horizontally through the opening in the flask until the inner end touches the neck pattern. The flask then is filled with sand and rammed. A flat parting is made all around the pattern and then additional flask parts are set on and rammed full of sand up to the top of the wabbler which in this instance is made longer than usual to serve as a sink head.

"The flasks are removed one section at a time, the pattern is drawn, the face of the mold is finished and blacked and if considered advisable it is dried in the oven or skin dried. The lower section of the mold is returned to place and is located by suitable marks placed there before the flask was lifted. These marks may take the form of rods or stakes driven in the sand alongside the lower edge of the flask, or the simpler form of a mark scratched in the sand. Where a mark is scratched in the sand with the point of a trowel or double ender it is advisable to wet it with a swab to render it more enduring.

"A channel is dug in the floor sand opposite the opening in the side of the flask and if a considerable quantity of iron is to be flowed through, this channel may be 8 or 10 feet long and in addition communicate with several short channels cut at right angles at both sides. This method of collecting the overflow iron is to be preferred to that in which the iron is collected in one large pool. A large body of iron may be broken readily into small pieces if the breaking process is attended to while the iron is passing from the liquid to the solid state, but it can be done more conveniently if the body of iron is already in the shape of pigs. Then, if for any reason the iron is not broken while it is hot, it may be broken after it has cooled.

"The heat from a large pool of iron may interfere seriously with the success of the burning operation. It is essential that the men pouring the iron shall at all times have complete control over the volume and direction of the stream and this is impossible if the men have to face the heat and glare from an unprotected pool of iron. The pool may be covered with a piece of sheet iron, but sometimes this expedient fails on account of the sheet iron buckling from the heat and sinking into the iron where, of course, it affords no further protection.

"Another objection to having a large pool of iron at any time in the foundry lies in the danger of some careless workman walking into it before the iron has solidified. Under ordinary circumstances connected with burning on a job, the chance of an accident of this kind happening is rather remote, but still the danger is there and there is no need of inviting accidents when they can be avoided.

"The crane ladle may be employed although some foremen prefer to use several 2-man shanks with iron caught in turn directly from the spout of the cupola. The method is immaterial so long as the iron is smoking hot when it is poured in the mold. Assuming that the crane ladle is employed, a stream is directed all over the exposed surface of the roll end by swaying the ladle slowly. The man directing the operation stands close to one side and with a bent rod *feels* the surface all over as the pouring progresses. This is a part of the process difficult to describe to one who never has tried it. It is one of those things that must actually be experienced. It is in the same class as the experience you realize when a fish takes your hook, or when you insert an iron bar in a pot of brass that has attained the proper pouring temperature. Each of those things conveys a definite meaning to your brain and when the experience is repeated you know exactly what to do, but when you attempt to pass the good word along to a third person you realize that at best the English language has its limitations. The nearest analogy I can think of is a sheet of ice that just has begun to turn soft. Before the molten iron commences to *take hold*, the surface of the casting feels smooth and hard. Gradually, as the iron penetrates the skin the feeling changes, as I said, to that of ice that has begun to turn soft. In addition the rod will indicate that the surface of the casting is sinking and when the man in charge has satisfied himself that the surface has been melted to a sufficient and uniform depth, or, in foundry terms, that the iron has *bit into the surface* all over, he directs an assistant to plug the outlet.

"Pouring continues steadily until the first section of the mold is filled. The ladle then is tipped back out of the way for a few seconds while the remainder of the mold is assembled in place. The remainder of the mold is filled with iron after which it is covered with a shovelful of blacking and a few shovelfuls of sand and allowed to cool. The overflow iron that ran into the pig bed is broken while still hot."

"That method might work with ordinary rolls" I said "but suppose you were confronted some day with the problem of mending one of these political steam rollers, how would you set about it?"

"That question" said Bill "shows all you know about politics. In the first place no person ever heard of a political steam roller breaking down; in the second place several spares are stocked before the campaign opens and in the third place if the worst comes to the worst a sufficient supply of hot air always is available to effect repairs without taking the machine to the foundry."

Crane Works Establishes New York Office

The Northern Engineering Works, Detroit, manufacturer of cranes, has established an office at 30 Church street, New York city. The office is in charge of H. C. Rood, who has been associated with the Northern Engineering works for several years. Prior to this time, the company was represented in New York by Messrs. R. A. Byrns and Harrison Dougherty, under the name of R. A. Byrns Co., Inc. They will continue as eastern representatives of the Towmotor Co., Cleveland, manufacturer of industrial tractors.

Manufacturer Addresses Toledo Foundrymen

Edwin S. Carman, secretary and chief engineer of the Osborn Mfg. Co., delivered an illustrated lecture on molding machines before the Toledo Foundrymen's association in the auditorium of the Scott high school, Toledo, O., Tuesday evening, Dec. 19, 1922.

Not less than 80 different types or different makes of the same type of electric furnaces have been used tried or suggested for melting copper, brass or bronze, aluminum or nickel alloys. Descriptions of these different types of furnaces are contained in Bulletin 202, just issued by the bureau of mines.

How Arsenic Affects Alloys

Comparison of Properties of Arsenical Antimony-Lead Alloys Is Made with Other Bearing Metals—The Former Better in Maintaining Their Hardness as Temperature Rises

BY HAROLD J. ROAST and CHARLES F. PASCOE

THE object of this investigation was to compare the arsenical antimony-lead alloy with some of the regular bearing-metal alloys. With this end in view, the following tests were made:

Chemical analyses to show the composition; thermal analyses; macroscopic examination of fractures; microscopic examination; tensile tests; crushing tests; scleroscope tests and brinell tests, at temperatures from 80 to 400 degrees Fahr.

All but the first two tests were conducted on both sand-cast and chill-cast specimens. For the purposes of this article the alloys have been numbered from 1 to 6; their compositions are given in Table I.

With the exception of No. 5, the alloys were taken as received from the manufacturer. About 40 pounds were melted in a graphite crucible and recast into small ingots to insure uniformity of composition; samples for analysis were taken from these remelted ingots. No. 5 was made up by the authors and remelted as in the other cases. A gas-fired crucible furnace holding a 40-pound graphite crucible was used. It was easily regulated as to temperature and condition of flame, whether oxidizing or reducing. All melts were kept at or below 1000 degrees Fahr., and no delay occurred between melting and casting the alloy. The size of crucible was varied according to the amount of metal required for the particular test at hand.

Paper presented at the New York meeting of the American Institute of Mining and Metallurgical Engineers.

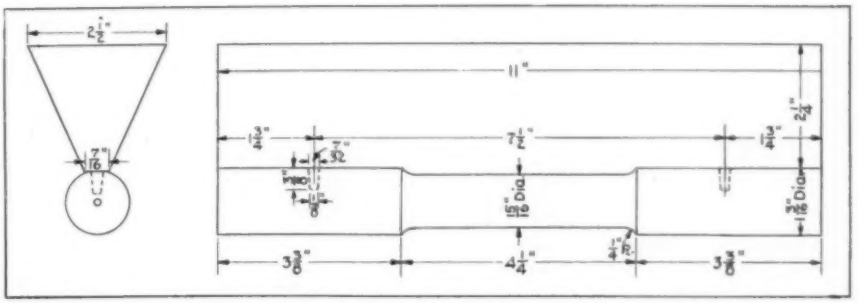


FIG. 2—DIMENSIONS OF THE TEST-BAR PATTERN

For the thermal analyses, about 650 grams of alloy was melted in a small graphite crucible, which was practically filled with the metal and brought to the required temperature. It was then removed to a suitable stand and a 900 degrees Fahr. thermometer inserted in a covering tube of electrically welded sheet iron that fitted the thermometer closely, thus permitting the easy removal of the thermometer from the solid mass at the end of the experiment. Owing to the thinness of the covering tube, practically no lag occurred. The thermometer was capable of being read to within 1 degree Fahr. The crucible was covered with an asbestos cover, through which the protection tube was inserted. Readings were taken at intervals of every 15 seconds, and the thermal curves shown in Fig. 1 were obtained.

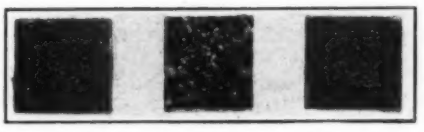


FIG. 3—FRACTURE OF SAND-CAST BARS —ACTUAL SIZE

The curves show that the addition of arsenic has little effect on the curve. With exception of alloy No. 2, the eutectic point varies but slightly. The decided lowering of the eutectic point in No. 2 must be borne in mind when considering the value of this alloy as a bearing metal. It is perhaps remarkable that the eutectic point of alloys of such variable constitution as Nos. 1, 3, 4, 5 and 6 should be at so nearly the same temperature; or in other words, that the softening point of all these alloys, or the danger point so far as the heating of the bearing is concerned, should be so little affected by such great changes in composition. Further a comparison of alloys 3 and 5 with 4 shows that the addition of arsenic has practically no effect on the first precipitation of crystals, or the eutectic point, notwithstanding the decided change in structure, which is commented upon later in connection with the micrographs. Cooling curve No. 3 shows that the precipitation started at a higher temperature than Nos. 4 and 5, which is in conformity with the increase of antimony in this alloy. Inasmuch as this investigation was primarily intended to deal with arsenic as a constituent of bearing metals and the constitution of the other babbitts has been the subject of much discussion, we have not considered the constitution of alloys 1, 2, and 6 to any extent.

For the purpose of fracture examination about 23 pounds of metal, including the bar, gate, and riser, were cast,

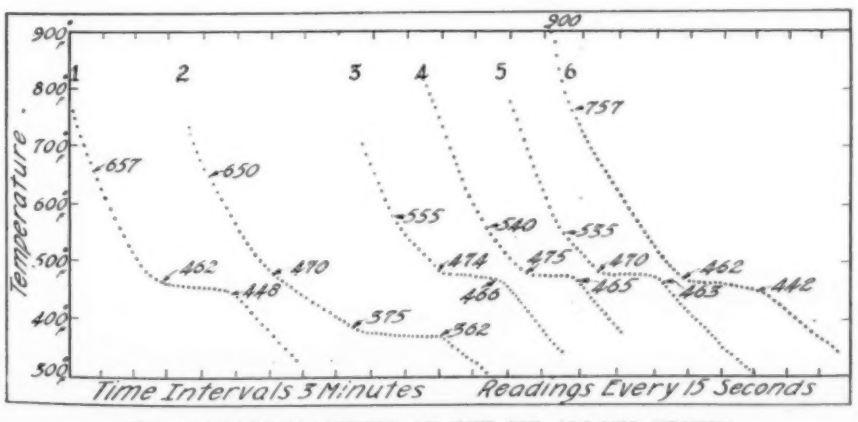
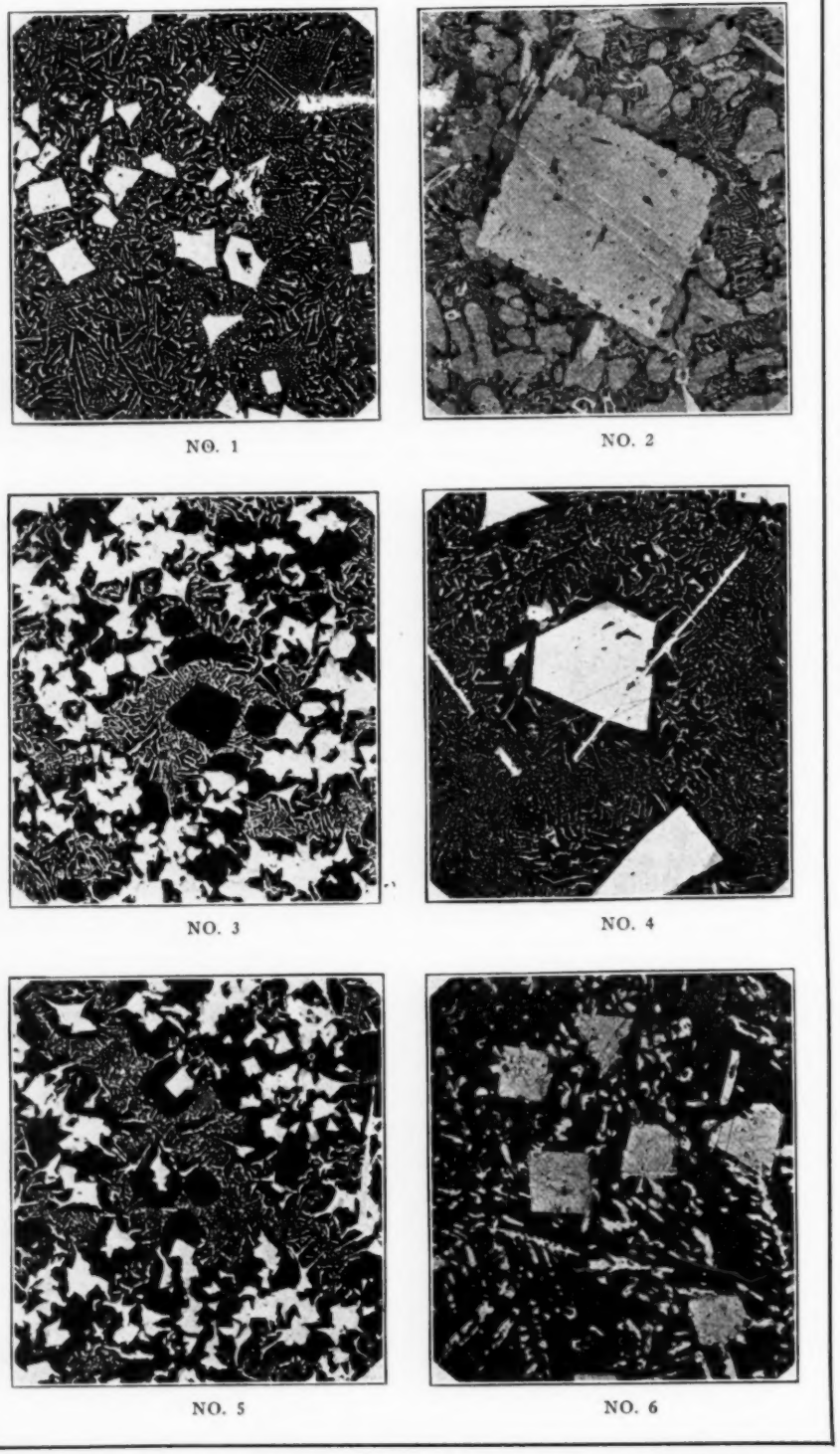


FIG. 1—COOLING CURVES OF THE SIX ALLOYS TESTED

Table I

Composition of Alloys Tested

Number	Lead Per cent	Antimony Per cent	Tin Per cent	Copper Per cent	Arsenic Per cent
1.....	82.64	12.95	4.40	0.01	none
2.....	27.54	9.94	59.87	2.65	none
3.....	77.65	20.75	none	0.13	1.47
4.....	82.95	16.85	none	0.20	none
5.....	83.78	15.35	none	0.05	0.82
6.....	0.15	7.87	84.13	7.85	none



NO. 1 NO. 2

NO. 3 NO. 4

NO. 5 NO. 6

FIG. 4—MICROGRAPHS OF SAND-CAST BARS OF THE SIX ALLOYS INVESTIGATED —X 70 DIA.

a pattern similar to that shown in Fig. 2 being used. We have found this pattern most useful for casting test bars, not only for white metal but for the brasses and bronzes, including manganese bronze. Examination of the chill fractures was made on the chill-cast test bars and brinell pieces, as described later. These were cast at 800 degrees Fahr., into molds heated to 212 degrees Fahr., with the exception of No. 6, which was cast at 900 degrees. The fractures of the alloys varied considerably. This variation was naturally more pronounced in the case of the slowly cooled sand-cast specimens, as shown by Fig. 3. It may be noticed that a small quantity of arsenic has an extraordinary refining effect. The coarse crystalline fracture of the arsenic-free alloy No. 4 is reduced to practically a silky fracture with the entire elimination of the large plate-like crystals.

Microscopic Examination

Pieces were taken from the center of the sound part of the sand-cast bars, for the sand-cast specimens, and small cylinders, as used for the crushing tests, were cast for the chill specimens. The casting temperature for alloys 1 to 5 was 800 degrees Fahr. and for No. 6, 900 degrees Fahr., as before, the chill molds were heated to 100 degrees. All the micrographs were taken at a magnification of 70 diameters and are therefore strictly comparable. The samples were etched with dilute hydrochloric acid, with the exception of the crystal study, Fig. 6, which was etched with ferric chloride to eliminate the ground mass and so accentuate the crystal. An examination of samples from the blocks used for brinell tests, as described later, showed practically the same structure as the chilled cylinders from which the photomicrographs shown in Figs. 4 and 5 were made. For the same reason as is given for the curves, the following general statement *re* alloys 1, 2, and 6 will suffice.

In Fig. 4, No. 1 shows the usual cubical crystals of tin-antimony SnSb, or gamma, compound, embedded in the softer lead-antimony eutectic which has a distinctly crystalline tendency. It is interesting to compare this lead-antimony eutectic with the eutectic in No. 4, which has presumably a similar composition. No. 2 has the tin-copper crystals as a primary constituent together with the cubic crystals of the tin-antimony compound embedded in a complex matrix, which apparently consists of crystallites, which are embedded in an eutectic. No. 6 gives greater evidence of the tin-copper crystals followed by the

cubic tin-antimony compound embedded in a matrix exceedingly rich in tin. Under high magnification, this matrix does not show any sign of the usual eutectic structure, although it has been suggested that it may be an eutectic consisting of tin with 1 per cent of copper. The most striking difference in alloys 3, 4, and 5 is the marked effect of the arsenic on the antimony crystals and the tendency to transform the cubic crystals of antimony into needle-like plates having a curved intention. The antimony in the eutectic of antimony and lead has a tendency to segregate away from the primary crystals, leaving dark structureless masses consisting probably of lead. This is also true of alloy No. 4 but to a less degree.

The copper content of 0.20 per cent in alloy No. 4 shows clearly, as the Cu_2Sb compound having its characteristic violet color, in the acicular crystals. From the amount present it would seem that practically all the copper is thus accounted for. The still smaller amount of copper present in the arsenical alloys exists apparently as the same Cu_2Sb compound in the center of some of the antimonial crystals, indicating that the copper compound was the first constituent to solidify and formed, in some cases, nuclei for the antimonial crystals. This copper compound is not readily visible under the low power but is obvious at a higher magnification, as shown by Fig. 7. From our observations, the action of the arsenic is concentrated on the antimony crystals compelling them to crystallize out in smaller units, and therefore larger numbers, and also distorting them, as before mentioned.

The alloys were heated to 800 degrees Fahr., with the exception of No. 6 which was cast at 900 degrees and poured into a sand mold similar to Fig. 2. The cooling was slow and every opportunity was given for the final resolution of the various eutectics. The bars were turned to 0.798 inches diameter and 4 inches between centers. The temperature of the testing laboratory was about 80 degrees Fahr. In the case of the chill-cast samples, the alloys were cast at the same temperature as those in the sand but into iron molds heated to about 212 degrees Fahr., the samples being cast vertically and turned down to the dimensions just given. The results of the tensile strength tests are as follows:

	Sand cast Lb. per sq. in.	Chill cast Lb. per sq. in.
1	8,620	8,950
2	8,820	11,000
3	6,160	7,280
4	5,520	6,130
5	7,030	7,980
1	10,900	13,980

Table II

Results of Brinell Tests

Alloy No.	80 deg. Fahr. 500 Kg.	100 deg. Fahr. 500 Kg.	212 deg. Fahr. 250 Kg.	300 deg. Fahr. 125 Kg.	400 deg. Fahr. 12 Kg.	80 deg. Fahr. 500 Kg.	Sand cast 80 deg. Fahr. 500 Kg.
1	21.0	16.5	10.5	8.6	4.6	18.6	18.6
2	19.3	23.8	11.9	8.5	..	25.9	14.3
3	21.0	15.9	13.6	10.7	6.5	17.8	20.1
4	17.2	12.8	7.6	7.1	3.8	14.3	15.9
5	19.3	15.3	13.0	9.0	5.2	17.8	..
6	31.2	29.7	15.6	11.2	7.8	32.6	28.4

*After heat treatment.

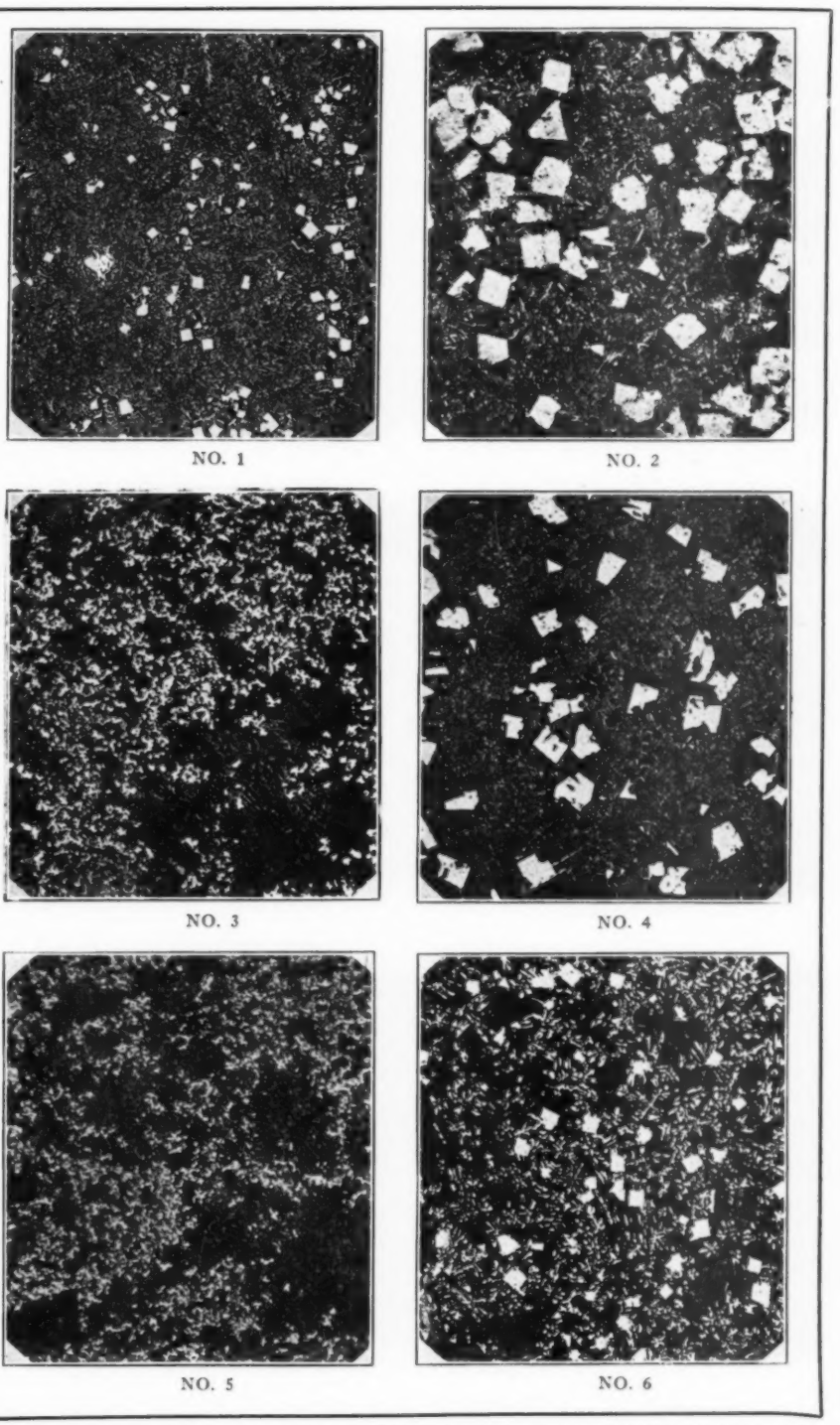


FIG. 5—MICROGRAPHS OF CHILL-CAST BARS OF THE SIX ALLOYS INVESTIGATED —X 70 DIA.

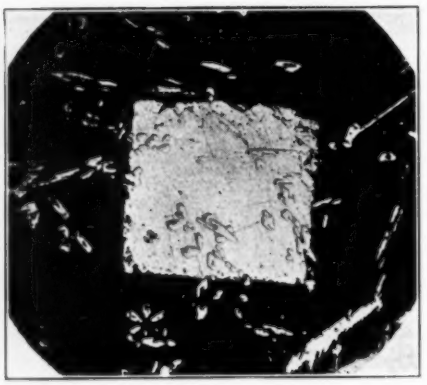


FIG. 6—CRYSTAL STUDY OF SAND-CAST METAL—X 70 DIA.

The elongation and reduction of area were not recorded, being only slight.

The results given suggest that the arsenical alloys Nos. 3 and 5, are less affected by casting conditions than the high-tin alloys Nos. 2 and 6, which are very susceptible to temperature conditions.

Crushing tests were made on both sand-cast and chill-cast samples poured under the same conditions as the test bars. The height of the cylinders after machining was approximately 2.5 inches and the diameter 1.25 inches. Loads of 1000, 5000, 10,000, and 15,000 pounds were applied with the results given in Table III.

After this test, increasing loads were put on the sand-cast cylinders until an apparent maximum was reached. This apparent maximum was:

Alloy No.	Lb. per sq. in.
1	21,980
2	16,580
3	19,770
4	19,330
5	20,880
6	24,430

Tests were made with the shore scleroscope on the chill-cast samples and the same test pieces were used for brinell tests, with the following results:

Alloy No.	Scleroscope results	Reduced to normal readings
1	13, 12, 13, 13	8
2	14, 12, 14, 12	8
3	9, 9, 10, 9	5
4	9, 9, 9	5
5	9, 9, 9, 9	5
6	19, 19, 20, 19	11

FIG. 7—CRYSTAL STUDY OF SAND-CAST METAL—X 850 DIA.

Table III

Results of Crushing Tests

No. of alloy	Original height inches	Reduction in height, inch, after a pressure of 1000 lb.	5000 lb.	10,000 lb.	15,000 lb.	Original diameter inches	Increase in diameter, inch, after a pressure of 1000 lb.	5000 lb.	10,000 lb.	15,000 lb.
				Sand - cast Bars						
1	2.508	nil	0.005	0.038	0.158	1.2480	nil	0.0016	0.0112	0.0588
2	2.525	nil	0.006	0.015	0.070	1.2511	nil	0.0004	0.0021	0.0169
3	2.530	nil	0.007	0.049	0.206	1.2490	nil	0.0010	0.0070	0.0960
4	2.512	0.004	0.012	0.112	0.392	1.2519	nil	0.0014	0.0232	0.1131
5	2.520	0.004	0.010	0.045	0.206	1.2498	0.0012	0.0018	0.0112	0.0742
6	2.500	nil	0.005	0.009	0.054	1.2453	nil	0.0005	0.0017	0.0140
				Chill - cast Bars						
1	2.528	nil	0.006	0.038	0.138	1.2498	nil	0.0011	0.0108	0.0404
2	2.540	0.002	0.006	0.015	0.120	1.2409	nil	0.0006	0.0022	0.0295
3	2.535	nil	0.007	0.029	0.124	1.2528	nil	0.0011	0.0073	0.0354
4	2.535	nil	0.007	0.075	0.353	1.2500	nil	0.0010	0.0200	0.1136
5	2.528	nil	0.006	0.039	0.151	1.2500	nil	0.0012	0.0098	0.0443
6	2.514	nil	nil	0.005	0.021	1.2512	nil	0.0000	0.0008	0.0052

Our experience, based on these figures and others not recorded, indicated that for this class of alloy the scleroscope did not provide a means of differentiating their hardness. For instance, alloys Nos. 3, 4, and 5 show no difference by scleroscope while indicating distinct differences under brinell, tensile, and crushing tests that were applied.

Brinell tests were made on a 10,000 pound Olsen machine using a special casting to hold the 10 millimeter ball and weighing the applied load. It was thought that by this method a more accurate result could be obtained than with the brinell machine generally used. The metals were heated in a bath of linseed oil by means of an electric heating unit and stirred constantly. A thermometer was used for temperature and the load was applied for 30 seconds. The test blocks were cast, at a temperature of 800 degrees Fahr. for alloys 1 to 5 and at 900 degrees for alloy 6, in rectangular iron molds 2½ by 4 by 1 inches. These blocks were turned in a lathe the under, or chill side, being used for the brinell test. The blocks were found to be uniform. It may be noticed that the arsenical alloys Nos. 3 and 5 are harder than the nonarsenical alloy No. 4; and that as the temperature rises Nos. 3 and 5 get harder than Nos. 1 and 2. A summary of the tensile, crushing and hardness tests, all on chill-cast samples, is given in Table IV.

Of the six alloys taken for comparison, the one with the high-tin base is undoubtedly the hardest, the strongest, and the most resistant to crushing loads. On the other hand, all the alloys stand 1000 pounds per square inch without deforming, and all deform but slightly at 5000 pounds; in other words, none would be expected to squeeze out of a bearing at ordinary loads. Leaving out No. 6, the arsenical alloys maintain their hardness as the temperature rises better than the other alloys. Structurally, the arsenical alloys have by far the finest grain while having hard crystals embedded in a softer but tough matrix. The arsenical alloys can be poured at a lower temperature than No. 6 and run more readily at, say 700 degrees Fahr., than any of the other alloys. Further, they show less sign of oxidation. In the matter of cost of components, the arsenical alloys (not taking into account the special cost of alloying in the case of the latter) will be less than the high-tin alloys but more than alloys Nos. 1 and 4. All of these tests have been carried out from the practical rather than the academic point of view and several lines of investigation are offered.

Table IV

Summary of Test Results on Chill-cast Bars

Alloy No.	Tensile strength at 80 deg. Fahr., Lb. per square inch	Reduction in height crushing at 10,000 Lb., at 80 deg. Fahr., inch	Hardness at 80 deg. Fahr.	Hardness at 212 deg. Fahr.
1	8,950	0.039	21.0	10.5
2	11,000	0.015	19.3	11.9
3	7,280	0.049	21.0	13.6
4	6,130	0.112	17.2	7.6
5	7,980	0.045	19.3	13.0

How and Why in Brass Founding

By Charles Vickers

Seek Causes for Alloy Segregation

Please inform us what causes segregation in the composition 88 per cent copper, 10 per cent tin, and 2 per cent zinc? We are using the best of materials, melt in an open flame furnace and use 1 ounce of 15 per cent, phosphor copper as a deoxidizer and remelt for the casting. The test bars pulled 42,000 pounds tensile; 28,000 pounds elastic limit, and 10 per cent elongation, but the customer is not satisfied.

Probably the segregation in the castings is due to failure to feed the massive parts sound by good-sized feeders. The test bars show good metal. The elongation is low, but that is likely due to the gating of the bars. We are in the dark as to how the segregation showed in the castings. There should be no tin sweat with this alloy. If the castings are broken and the fractures are not homogeneous, then some segregation did occur, and it must have been the segregated part of the casting fed the lower parts. The eutectic seeped away from between the crystals; this is indicated by lemon-colored areas. The remedy is to use chills or sometimes properly placed risers can be depended upon, and in some cases it is advisable to hasten the cooling by the application of water.

Shrink Holes Caused by Faulty Alloy

We are making aluminum patterns that are shaped with heavy sections which cannot be lightened with cores, and we have a great amount of trouble due to shrink holes. We have tried risers in a number of different ways but cannot get successful results. In one instance we cast a medium heavy pillow block with three risers over the sections of the mold containing the greatest amount of metal. This casting was badly shrunken on the cope side. We then increased the size and height of the risers and cast another. This casting held up well on the cope but was badly drawn and wrinkled on the drag side. We think the risers should give us good results but are unable to make these castings successfully.

We are inclined to the belief the alloy is at fault, and think a trial of a different alloy advisable. From the fact that the castings draw and wrinkle in the drag we would suspect that a large amount of zinc is present, as this element will cause such difficulty. A No. 12 aluminum, which contains 92 per cent aluminum and 8 per cent copper, would run these castings successfully, and we suggest that one or more heats of such an alloy be tried. There is no question but that the castings would be free of defects on the underside provided the shrinkage on the cope side had been controlled by proper risers.

Want To Make Alloy from All Scrap Metal

We should like to have a formula for converting all scrap metals into a good grade of bronze to be cast into bushing sticks. What proportion of copper should we add to old bronze to convert it into suitable material.

Scrap metals are mixed metals and cannot be reckoned like copper to form the base of an alloy. Scrap may be melted and cheapened by the addition of lead and zinc and it also may be improved by the addition of copper and tin, but to do either intelligently the analysis of the scrap must be known. If the old bronze is good metal, it may be used without addition of any kind. If it is tough and difficult to cut, a little lead will remedy the trouble and may be added in varying amounts up to 5 per cent. About two ounces of phosphor copper to the hundred pounds of metal will materially assist in removing oxides.

A good plan is to make an alloy of half scrap and half new metal provided the composition of the scrap is known. If it is not known, you are working in the dark and the result may be highly disappointing. A good formula for bushing metal follows:

FORMULA FOR BUSHING STICKS

	Per cent
Copper	90
Tin	6.50
Zinc	2
Lead	1.50

Usually it is economical to buy ingot metals of known analysis, in place of using miscellaneous scrap. Before buying bulk scrap from dealers or junk men, it is advisable to consider the possibilities afforded by ingot metals handled by reputable dealers. The address of these men may be found in the advertising columns of THE FOUNDRY.

Using Brass Scrap for Low Pressure Parts

We desire to use yellow brass scrap which we obtain from stampings and turnings from yellow brass sheet, rods and tubes, by remelting it in our foundry to cast yellow brass parts, which must be homogenous, that is free from porosity, and will stand a pressure of from 30 to 40 pounds air per square inch. Will you kindly advise whether this can be done successfully?

No difficulty should be encountered in using scrap of the composition outlined provided it is handled well while it is being melted. The light scrap should be cabbaged, and the turnings passed through a magnet machine to remove all iron chips and filings. If crucibles are used to hold the metal while it is melting, a good way is to charge a few pounds of the cleaned chips in the bottom, the cabbaged scrap on top, and melt. The melting of scrap will be greatly facilitated by the use of deepeners on the crucibles. These are merely the bilges of old pots, the bottoms being cut off with a hatchet.

In using the scrap a formula should be worked to, and a good one for the castings mentioned is copper, 70 per cent; zinc, 26 per cent; lead, 2.50 per cent; and tin, 1.50 per cent. To get a working formula: First, estimate as closely as possible the amounts of the different forms of scrap the factory normally will produce. Then make up a representative heat, and run ingots. From every ingot take drillings, mix thoroughy and make an anaysis, and from this anaysis the additions can be computed. Thus, supposing the scrap is 70 copper, 30 zinc, and after ingoting the anaysis is 72 copper, 28 zinc, and 50 per cent is to be used in each heat, the remainer new metal. In every 50 pounds of scrap there is 36 pounds copper, and 14 pounds zinc. Then the heat will read scrap 50 pounds; copper, 34 pounds; zinc 12 pounds, lead 2.5 pounds, and tin 1.5 pounds. The 50 pounds of scrap will consist of the determined amounts of turnings, rod and sheet used in the trial heat of ingots. Should any trouble from leakers develop, add one ounce of phosphor copper per hundred pounds of metal melted just previous to pulling the pots.

Time Study Means Progress

Detailed Discussion and Amplification of Six Fundamental Reasons for the Adoption of a Time Study System Presented—Workmen's Co-operation Needed—Qualifications of Time Study Observer Enumerated

BY A. J. KRAMER

FOUNDRYMEN who have not yet taken advantage of time study methods for arriving at improvements in equipment, price setting for piece work, task setting for bonus or premium payment, or to maintain low production costs, are not utilizing a sure legitimate and praiseworthy means for attainment of those features most essential to profitable manufacturing. A large portion of the total utilization of time studies consists in setting piece work prices equitable in the strictest possible sense of the word, fair to the employer, and just to the worker.

The foundry, as a field for the application of scientific management and time study work in particular, presents wonderful possibilities. While the work of the foundry is of such scope as to call for ability above the average in solving the problems of management, and unlimited ingenuity in the making of castings, much of the productive work is of a sufficiently repetitive nature to enable standards to be set so that the work of setting task times and piece work prices becomes more simplified and accurate.

Among the many good reasons why time studies should be taken the six most important are:

1. To set up standard times as a basis for proper piece work prices, equally as fair to the workman as to the employer, so that a man may earn a just day's wage for a just day's work.

2. To set piece work prices as nearly accurate as possible and avoid any question as to their correctness, or as to the soundness of the method used in their determination.

3. To increase the efficiency and earning power of the workman and consequently increase production through the elimination of fatiguing and unnecessary motions.

4. To establish equality and uniformity in prices for similar classes of work and for similar occupations, through standardizing working conditions and equipment.

5. To seek out ways and means of improving methods and equipment, thereby increasing production.

6. To relieve the foreman of a great deal of detail and worry over matters which should be extraneous to the executive functions. These constitute his chief responsibility and should therefore be his first duty.

As an illustration of the first reason, consider the shops where the time study method of setting prices is not used, and where piece work prices as a rule are estimated. It has been found in many cases that the personality of those who estimate prices is to some extent reflected in such estimated prices for piece work.

Those with a liberal turn of mind show tendencies toward generosity in their prices, and in like fashion, *tight* prices are the rule in departments where

From a paper presented at the convention of the American Foundrymen's association at Rochester, N. Y. The author is connected with the International Harvester Co., Chicago.

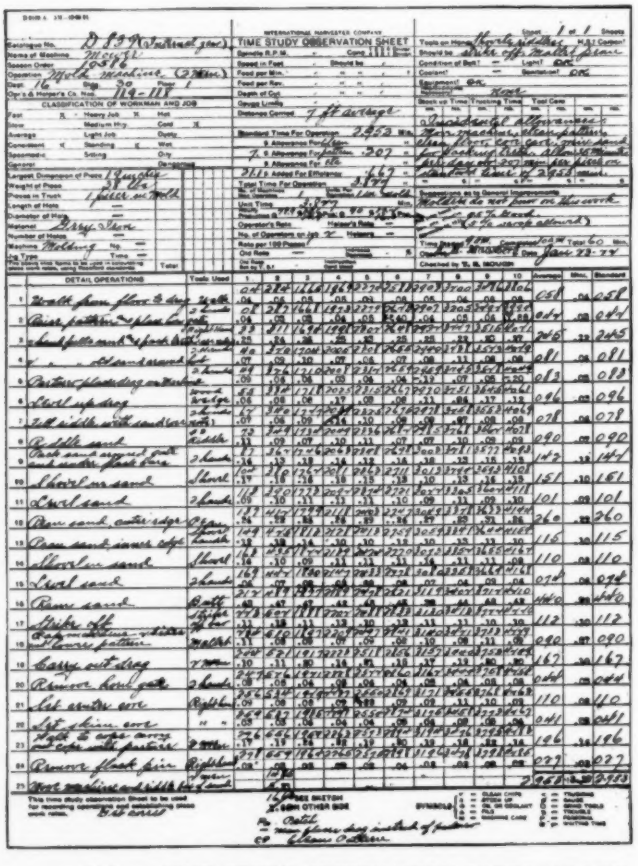

TIME STUDY OBSERVATION SHEET

FIG. 1—TIME STUDY OBSERVATION SHEET (FRONT)

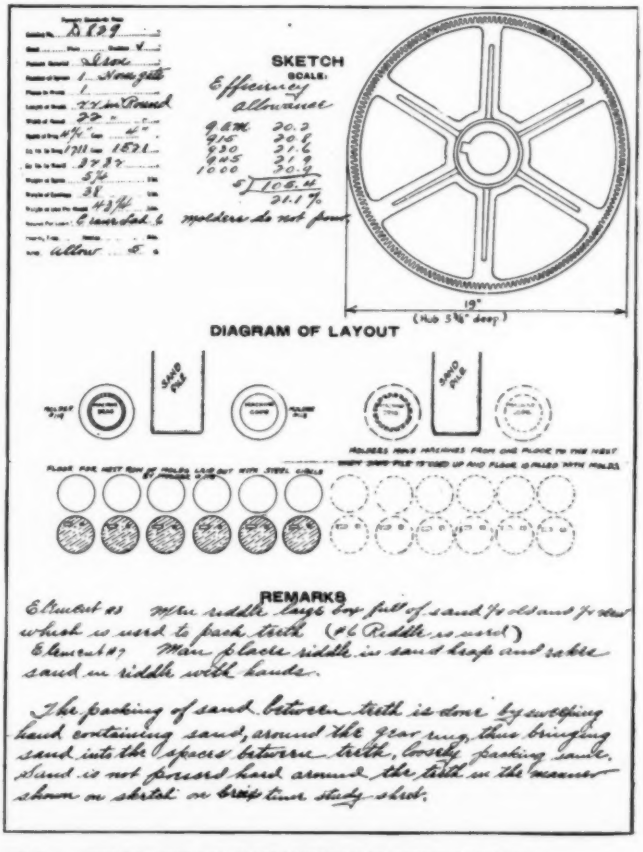


FIG. 2—TIME STUDY OBSERVATION SHEET (BACK)

the persons who estimate prices are of a less liberal turn of mind.

High prices are unfair to the employer, and low prices are equally as unfair to the workman. A correct price gives the workman a chance to earn a just day's wage and in so doing he is bound to give a just day's work in return. By being satisfied with his work and remaining in continuous employment, he helps reduce the labor turnover, at all times a problem of importance.

An analysis of the second reason shows it to bear a certain relation to the first reason, in which we attack the method of setting prices by estimating. Those who have to do with the setting of piece work prices must always be in a position to show reasons for their decisions and sometimes prove the correctness of the prices, especially in cases wherein the workman fails to earn the anticipated wages. In some factories, prices are estimated by foremen, and while the foreman usually is well qualified in this regard, the departmental morale suffers when he is placed on the defensive and made to bear the brunt of criticism for disputed prices.

There is no method of setting piece work prices or task times more reliable than that of time study, and the absence of the unbiased judgment of the time study observer with reference to conditions surrounding the job, manner in which the workman functions, possible recommendations of a better method of manufacture, as well as other consideraations, are losses which immediately affect costs and therefore curtail profits.

The third reason relates to the increasing of efficiency and production. Time study, determines which motions on the part of the workman are necessary and which are unnecessary, and standards can be set on this basis and the workman taught how to perform his work with the fewest possible motions and in the most efficient manner. Thus converting the time formerly lost in unnecessary motions into useful work, increasing production and giving a consequent increase in earnings on the part of the workman.

To establish equality or uniformity of prices for similar classes of work in various branches of the foundry as outlined in the fourth reason is a result much to be desired and one which can be had only through standardization of working conditions and standardization of equipment.

Two men in different places, even under the same conditions cannot always estimate prices alike, nor can any one man estimate prices exactly the same on different occasions. For this reason it frequently happens that of two pieces nearly alike, one of them has the lower price when it should have the higher, and this becomes the direct cause of protest and grumbling on the part of the workman. If an attempt is made to cut the high price serious results may follow.

Comparison Possible

Time study shows up lost time and enables the observer to compare times of performance of work done in one department with the times of another department doing similar work and to determine the reasons for any discrepancies. It also is the basis for the improvement of equipment and methods with their attendant increase in output as outlined in the fifth reason. In laying out work in the sequence of operations, time studies are particularly valuable in determining standards and so balancing the time for each division of the operation that the work may be handled progressively. In foundry practice the work of gangs may be so apportioned that the task is equally divided between the men.

With reference to the sixth reason relieving the foreman of the worry connected with price setting, it is obvious that the more duties a foreman has to perform personally, the less are his chances of doing all of them thoroughly and satisfactorily. He is the key man in industry. His lot should not be made more arduous. He should be relieved of any duties which can be performed to better advantage by persons who specialize in certain well defined functions. The function of rate setting therefore should be delegated to a department charged with that responsibility, and whose work covers this feature in all departments of the plant.

In the work of setting standards for the determination of task times and hourly production, time studies can be used to advantage. A series of charts, showing molding time for hand pattern, squeezer and machine molding based upon cubic contents of the flask, serves as an excellent guide for the foreman in checking production and for the time study observer in checking his work.

Lost motion causes early fatigue of the worker, consumes valuable time, hinders production and contributes to high costs. Often it represents the deviding line between success and failure, and its elimination will result in the reduction of fatigue, greater production, decreased cost and increased profits. Time study also shows how to plan jobs and arrange work to eliminate all lost motion.

In its true sense, fatigue has to do with the tiring of the worker and with relaxation sought through application of time for personal requirements. To determine the extent of such natural fatigue and personal necessities and their effect upon production, a series of pro-

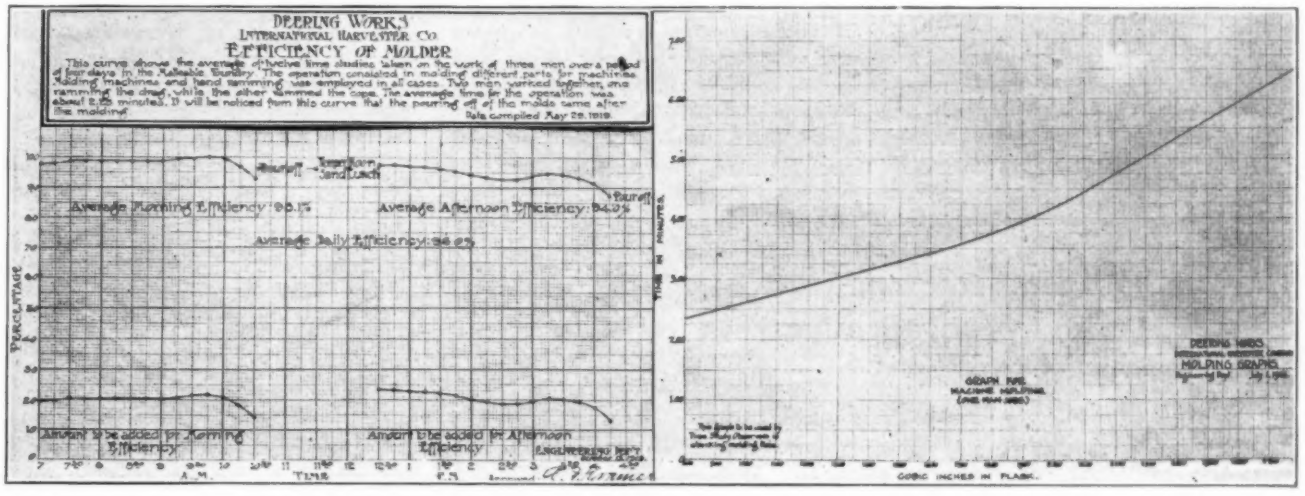
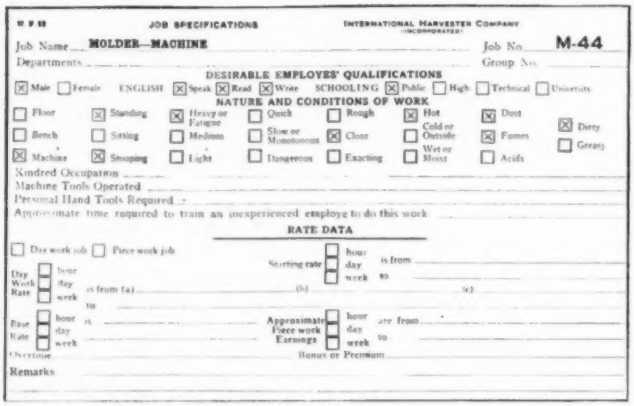


FIG. 3—THIS CURVE SHOWS THE AVERAGE OF TWELVE TIME STUDIES TAKEN ON THE WORK OF THREE MEN IN A MALLEABLE FOUNDRY OVER A PERIOD OF FOUR DAYS FIG. 4—CURVE USED BY TIME STUDY OBSERVERS IN CHECKING MOLDING TIME ON ONE-MAN MACHINE MOLDING JOBS



W. P. M. JOB SPECIFICATIONS INTERNATIONAL HARVESTER COMPANY (INCORPORATED)

Job Name MOLDER—MACHINE Job No. M-44

Department Group No.

DESIRABLE EMPLOYES' QUALIFICATIONS

☒ Male ☐ Female ENGLISH ☒ Speak ☒ Read ☒ Write SCHOOLING ☒ Public ☐ High ☐ Technical ☐ University

NATURE AND CONDITIONS OF WORK

☐ Floor ☒ Standing ☒ Heavy or Fatigue ☐ Quick ☐ Rough ☒ Hot ☒ Dust ☒ Dirty

☐ Bench ☐ Sitting ☐ Medium ☐ Slow or Monotonous ☒ Close ☐ Cold or Outside ☒ Fumes ☐ Greasy

☒ Machine ☒ Stooping ☐ Light ☐ Dangerous ☐ Exacting ☐ Wet or Moist ☐ Acids

Kindred Occupation

Machine Tools Operated

Personal Hand Tools Required

Approximate time required to train an inexperienced employe to do this work

RATE DATA

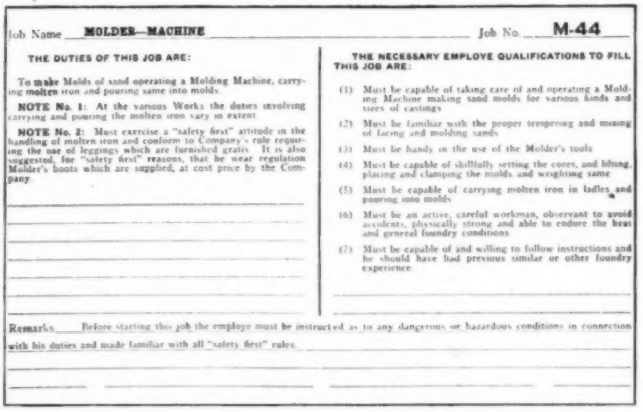
☐ Day work job ☐ Piece work job

Day Work Rate ☐ hour ☐ day ☐ week Starting rate ☐ hour ☐ day ☐ week is from to

Base Rate ☐ hour ☐ day ☐ week Approximate Piece work Earnings ☐ hour ☐ day ☐ week are from to

Overtime Bonus or Premium

Remarks



Job Name MOLDER—MACHINE Job No. M-44

THE DUTIES OF THIS JOB ARE:

To make Molds of sand operating a Molding Machine, carrying molten iron and pouring same into molds.

NOTE No. 1: At the various Works the duties involving carrying and pouring the molten iron vary in extent.

NOTE No. 2: Must exercise a "safety first" attitude in the handling of molten iron and conform to Company's rule requiring the use of leggings which are furnished gratis. It is also suggested, for "safety first" reasons, that he wear regulation Molder's boots which are supplied, at cost price by the Company.

THE NECESSARY EMPLOYE QUALIFICATIONS TO FILL THIS JOB ARE:

(1) Must be capable of taking care of and operating a Molding Machine making sand molds for various kinds and sizes of castings.

(2) Must be familiar with the proper tempering and mixing of facing and molding sands.

(3) Must be handy in the use of the Molder's tools.

(4) Must be capable of skillfully setting the cores, and lifting, placing and clamping the molds, and weighting same.

(5) Must be capable of carrying molten iron in ladles and pouring into molds.

(6) Must be an active, careful workman, observant to avoid accidents, physically strong and able to endure the heat and general foundry conditions.

(7) Must be capable of and willing to follow instructions and he should have had previous similar or other foundry experience.

Remarks Before starting this job the employe must be instructed as to any dangerous or hazardous conditions in connection with his duties and made familiar with all "safety first" rules.

FIG. 5—JOB ANALYSIS AND SPECIFICATION CARD USED IN OCCUPATIONAL RATING (FRONT) FIG. 6—JOB ANALYSIS AND SPECIFICATION CARD (BACK)

duction studies can be made and translated into charts showing productive efficiency at every moment of the day. One of these charts, shown in Fig. 3, represents the relative efficiency of a certain group of molders.

One of the greatest aims of time study is to place in the hands of the foreman and workman suitable instruction cards on which are shown a summary of the time study and detailed information under which the conditions of the study can be reproduced at any time. The value of this card as a permanent record has been proved on many occasions.

Floor gangs, pourers, truckers, sorters, trimmers, grinders, annealing pot packers and dumpers and mill men can be placed on a piece work, bonus or premium basis, as well as molders. The problem to be solved may vary somewhat with each class of work, but on the whole depends entirely upon the time elapsed in turning out a given production and the amount of money which the employer expects the workman to earn as a just day's wage.

After prices have been set by time study, they should not be cut unless some changes in operation or equipment are effected, and a change of this character must be a decided one. Merely transferring a job will not justify a cut. The workman must have confidence in the system or he will not give his co-operation and co-operation is the keynote of success in time study work. It is good policy to explain to the workman the method used in determining prices by time study, because the more mysterious it appears to him, the harder it is to get his approval and co-operation.

Foundry, Mill Room and Core Room Piece Work Occupations

(Classified According to Occupational Rating Plan)

Group	Job No.	Occupation
A	C-28	Chipper—hand (light work)
A	C-42	Coremaker—simple light cores
A	G-31	Grinder operator—rough (light work)
A	L-3	Laborer—annealing pot dumper
A	L-18	Laborer—casting trimmer
A	L-21	Laborer—charger (malleable iron melting furnace)
A	L-35	Laborer—foundry (sand cutter and shaker out) Light molds or working after pouring
A	L-60	Laborer—wheeler (miscellaneous material)
A	M-31	Mill operator—tumbling (light work)
A	S-4	Sand blast machine operator—tumbling mill type
B	M-43	Molder's helper—machine (simple jobs)
C	G-30	Grinder operator—rough (heavy work)
C	L-4	Laborer—annealing pot packer
C	L-34	Laborer—foundry (molten iron pourer)
C	L-35	Laborer—foundry (sand cutter and shaker out) Heavy molds or working during pouring
C	M-30	Mill operator—tumbling (heavy work)
C	S-4	Sand blast machine operator—rotating table type
D	M-43	Molder's helper—machine (major jobs)
E	C-29	Chipper—hand (heavy work)
E	C-30	Chipper—pneumatic
E	M-42	Molder—floor (annealing pot)
F	M-43	Molder's helper—floor
G	C-43	Coremaker (all round) Major cores but not for engine parts
H	C-43	Coremaker (all round) Major cores for engine parts
H	S-3	Sand blast hose operator
I	C-46	Core setter—mold
I	M-37	Molder—bench—simple work
I	M-39	Molder—brass—simple work
I	M-44	Molder—machine—(simple jobs)
I	M-47	Molder—squeezer
J	M-44	Molder—machine (major jobs)
K	M-37	Molder—bench—major work
K	M-39	Molder—brass—major work
L	C-48	Coresetter—engine multiple cylinder block
L	M-40	Molder—floor

Experience Imperative

It always is advisable to put on molding work, time study observers who have had molding experience, because while every observer may be able to take the general run of studies, an experienced molder is best qualified to take foundry studies from which the most value can be obtained.

In most time study organizations will be found men who have natural aptitudes for certain kinds of work which qualify them as experts. Foundry time study observers should be specialists in foundry work, and should have worked as molders on piece work before being selected as members of the staff. I state these facts because I believe in the importance of choosing trained men as observers in the foundry and because a trained man, knowing the thoughts and habits of molders as well as their trade secrets, readily can discern whether the person under observation is working efficiency or not.

In making time studies an important part of the task is to gather all information possible pertinent to the work so that an intelligent record may be had which will enable the observer to know whether or not the work is necessary, its importance in the production scheme

and whether or not conditions can be improved or parts of the operation's eliminated or changed to give greater efficiency.

Therefore, it is the first duty of the time study observer to study the work and make notes of faulty conditions and improper layout of work, as well as other items which tend toward reduction of efficiency. He should examine the flask sections and see that they open and close quickly; that the flask pins are not worn to any extent. He then should see that the molder has a sufficient supply of cores, nails, chills, etc. He should also observe the molder's equipment, see that it is suited for the job and placed within easy reach.

Many jobs require few, or no changes, especially those on which experienced molders are working, and the observer quickly can set time study prices on such jobs. Sometimes however, time studies are taken to emphasize faulty conditions and to aid in obtaining better equipment but in such cases the studies are used only as a basis for the correction of such conditions.

Dividing Job Into Elements

It will be noted in the time study sheet shown in Figs. 5 and 6, that importance is given to the classification of workman and job, in which the workman is classified as fast, slow, average, consistent or spasmodic; the job as heavy, medium or light; and conditions surrounding the job as hot, cold, dusty, wet, oily, or dangerous; and whether the workman stands or sits at his work. This classification is of permanent value as a record of conditions found when the time study is made, aids materially in selecting suitable fatigue allowances and proper base rates, and is in line with the plan of occupational rating and job analysis.

It is necessary in the taking of time studies, that the whole operation be divided into elements which may be timed with ease. This is done that an analysis of the operation may be made and a standard time for the operation arrived at by means of comparing corresponding readings for each element as they recur throughout the cycles studied.

Elements of operations are those details which go to make up the complete operation, and usually are terminated by some definite movement on the part of the workman such as laying down one tool and picking up another. These movements are known as *cut off points* and make it easy for the time study man to observe the intervals while reading his watch and making entries on the time study sheet. The more finely the whole operation is divided into elements, the better can the operation be analyzed and the standard time built up.

The standard time, to which are added all necessary allowances for fatigue, efficiency, and incidental work, constitutes the basis upon which is determined the production which the workman must attain to earn his base rate.

In setting piece work prices the hourly base rate has a direct relation to the time study price and to the earnings of the workman. It is the medium used to convert production per hour into the piece work price, and to obtain an equitable piece work price we must have an equitable base rate. The hourly base rate is that amount of money which the employe should receive for the satisfactory performance of a given duty, and is a factor of first importance in establishing just piece work prices.

The equitable base rate can be established only by an analysis of the occupation, by which is determined the value of the job to the industry, based upon the skill required, difficulty of training, hazard involved, and other considerations. It should always be founded on the basic principle of a just wage for a just day's work.

When base rates are set by a method having this as its fundamental principle, earnings resulting from such a policy will vary, depending upon individual effort. The desirable class of employes

INTERNATIONAL HARVESTER COMPANY
INSTRUCTION CARD

Cat. No. D-839 Internal Gear — Complete Description of Operation: Mold - Machine (2 men)

Number of Men on Job	Machine No.	GOVERNING CONDITIONS: Tools Used	No. of Tools or Drills Operator Should Have	Material	Speed in Feet / Feed per Rev.	Depth of Cut / Gauge Limits
2	Molding Machines	X (Carbon? H.S.?)	X	Grey Iron	Spindle R. P. M. X; Cone 1234 Driver 4321 Driven X	X

ELEMENT	DETAIL OF ELEMENTS AND INSTRUCTIONS TO OPERATORS	TOOLS USED	MINUTES TO COMPLETE
1	Walk from floor to drag	Walk	.058
2	Raise pattern & place horn gate	2 hands	.042
3	2 handfulls of sand & pack teeth	R.hand	.245
4	2 handfulls old sand around hub	R.hand	.081
5	Partner places drag on machine	2 hands	.083
6	Level up drag	Wedge	.096
7	Fill riddle with sand	2 hands	.078
8	Riddle sand	#3 Ridl.	.090
9	Pack sand around gate and under)	2 hands	.142
10	Shovel in sand (flask bars)	Shovel	.151
11	Level sand	2 hands	.101
12	Pean sand, outer edge	Pean	.260
13	Pean sand, inner edge	shovel handle	.115
14	Shovel in sand	Shovel	.110
15	Level sand	2 hands	.074
16	Ram sand	Butt	.440
17	Strike off	S.O.Bar	.112
18	Rap machine 2 sides & lower pattern	Mal-let	.090
19	Carry out drag	2 men	.167
20	Remove horn gate	2 hands	.044
21	Set center core	R.hand	.110
22	Set skim core	R.hand	.041
23	Walk to cope, carry out cope with	partner	.196
24	Remove flask pin	R.hand	.027
25			2.953
26	Move machine; also riddle)		
27	box of sand ---------- 9.21 min.)		
28	Get cores ---------- 1.80 min.)		
29	both included in time allowance)		
30	added to standard time on face of card.)		
	TOTAL TIME		

Machines on which proper speed and feed can be obtained.

ENGINEERING DEPARTMENT

This form to be used for recording data from time study sheet and is sent to head of department as complete instructions showing method and order of operations.

FIG. 7—INSTRUCTION CARD DETAILING PROGRESSIVE STEPS

will earn at least the base rate, the good class will earn more and the excellent class of employes will earn a still higher wage.

In the occupational ratio plan, the fundamental idea is that of remuneration for daily piece work occupations in proportion to their industrial worth, rather than for the personal attainments of those who happen to fill the occupations. Thus in foundry work if we study the duties and qualifications of the several occupations, we find enough difference in them to justify the rating of one group of occupations higher or lower than some other groups.

In the list of foundry piece work jobs shown in the accompanying illustration there is a range in values from the foundry laborer in the lowest group to the floor molder in the highest group. Each occupation has a specific name and number, which greatly facilitates the hiring, placing and proper rating of men.

Job Analysis Card

For purposes of permanent record, a job analysis card is used, similar to that illustrated in Figs. 5 and 6. Upon this card are recorded the duties required and qualifications desired of workmen filling the occupation. Space is provided for recording the name and number of the occupation, the group in which it belongs, and the departments. Checkmarks in small squares designate the desirable qualifications as well as nature and conditions of work. Suitable space is provided for comparable occupations, for a description of machine tools operated and personal hand tools required, and provision is also made for permanent rate data pertaining to the occupation. This permits the employment manager at all times to consult the record rather than trust to memory for figures.

Modern industry has seen fit to adopt and delegate specific functions to the employment department, safety department, engineering and planning departments, and the delegating of certain functions to a time study department as a step further in progressive management.

Where the installation of a time study department is contemplated, the personnel should be such as to inspire the confidence of those concerned, and cause them to cheerfully relinquish the price setting activity to such organization. Therefore, it is obvious that such personnel for time study work in foundries must include observers who besides having had molding experience, are resourceful, tactful, possess initiative and have an analytical turn of mind.

Time studies taken by observers having such qualifications are not only of great value as a price setting medium, but when comparing operations between different shops. Discepancies in more inefficient methods readily can be detected and corrected when there is a time study available showing the correct method in detail.

Price setting by a duly appointed person or organization is as much a sign of advancement as any of the other moves which progress in industry has made necessary, and should not be regarded as a curtailment of authority or responsibility of anyone concerned.

Consider the older method of setting a price on a job and leaving the molder to make wages or quit, or in some instances earn more money with greater ease than his neighbor who might have a *tighter* price, and contrast it with the time study method of setting standards and teaching the molder how to perform the work in the allotted time. Under the latter plan, the molder may accomplish more and with less fatigue. He is satisfied that fair consideration was given him in setting his price, and he will be more contented.

Varied Views Presented

To the Editor: It is stated in an article by M. M. Marcus, published in the Dec. 15 issue of THE FOUNDRY that "Where abrupt changes in section cannot be avoided shrinkage may be overcome by the use of chills on the heavy sections, which tend to accelerate cooling, or by using risers on the light sections as closely as possible to the point at which the different sections join. The risers or shrinkage heads should be heavy enough to feed the light sections."

Is it not a fact that the lighter section by virtue of being light solidifies first and after freezing cannot be fed? All cooling is from the surface to the center of the casting; and the shrinkage caused by contraction of the mass after solidification is located as a result of the metal that solidified last rather than by that which solidified first. In other words, it is the slow cooling of the heavy section rather than the rapid cooling of the lighter section that causes the shrink. Were the heavier section adjoining the lighter section fed by a riser of the proper size and through a gate or neck thicker than the heaviest section of the casting, the shrink would be driven from the casting into the riser where the molten metal was last to solidify. The riser, however, should feed the heavy section and not the light section. Use of the riser is the proper method, where its location is possible, as too often the use of chills only drives the shrink to some other part of the casting.

Further is is stated that "The silicon exerts no influence upon the carbon during melting. If during the heat a test bar were poured at an early stage the fracture would be gray, because the silicon is high enough to prevent the carbon from remaining permanently combined with the iron after solidification. However by holding the metal in the furnace, the oxidizing action of the furnace gases gradually lessens the silicon in the bath and a point is finally reached where the carbon will remain in the combined state and a sample then will be uniformly white." What is said about the carbon combining is true, but the explanation of the cause may be somewhat misleading. Chemical analyses of a test taken as soon as the iron is molten enough to pour will show that practically all the silicon loss has been accomplished, in spite of the fact that such a test shows a gray fracture. After the iron is melted to a bath, the combining of the carbon will depend first upon the increase in temperature and secondly the reduction in total carbon which is accomplished by the increased temperature, and not upon further silicon loss as suggested. In other words, practically all the silicon loss occurs before skimming, and all the carbon loss after skimming, providing furnace operation is normal.

Although the author of the article referred to is backed by some of the leading authorities on the sulphur-manganese formula given; namely, "manganese twice the sulphur plus 15," I have found that twice plus 10 gives better results and predict that some day the formula he has given will be changed.

Many malleable foundrymen will agree that the elastic limit of 29,000 pounds per square inch and the ultimate strength of 44,000 pounds per square inch, mentioned in the article, as representing a fair sample of malleable cast iron, is too low. An ultimate strength of 54,000 pounds per square inch with an elastic limit of 35,000 pounds per square inch is not considered unusual in many foundries.

J. B. Deisher,
Rochester, N. Y.

The Portland Foundry Co., Portland, Conn., has purchased the John T. Young Co., Norwich, Conn., manufacturer of heaters.

Throws Light on Steel Melting

Experiments Made Under Stress of War Necessity Result in Procedure for Melting Steel Scrap in the Cupola—Priming Charge of Pig Iron Deemed Imperative to Maintain Fluidity

BY G. MUNTZ

IN A recent issue of THE FOUNDRY, the writer noted a short article, Melted Steel in the Cupola, by Robert E. Masters and this brings to mind some observations on the subject. So-called semi-steel has been produced in converter foundry practice for over 30 years, the object being to produce not a close-grained iron, but to reduce the percentage of low phosphorus pig iron in the cupola charges. It was sought thereby to insure full consumption of the home-made steel scrap and also to enable the steel foundryman to reduce his cost of production by the use of foreign steel scrap, which as a rule sells for a fraction of the cost of low-phosphorus pig iron.

Cupola practice has reached its greatest efficiency in converter steel foundries, and converter operators often smile at the boasts of their gray iron *confreres* who point proudly to cupola charges containing 40 per cent and over of steel scrap. Converter operation, for many years, limited steel scrap admixtures to 30 per cent; not because higher precentages of scrap could not be melted in the cupola, but on account of building up those elements which could not be eliminated in the converter, notably sulphur and phosphorus.

European cupola practice for many years, has called for 40 per cent steel scrap admixtures when producing the dense metal poured in such castings as locomotive cylinders and others of similar nature; but they never thought of naming it semisteel. It was considered just a good grade of gray iron. To this day, few gray iron foundries care or dare to exceed a 40 per cent scrap burden.

In converter operation, we have been faced for years by increasing costs of low phosphorus pig iron, and willy nilly have been obliged to add to our steel scrap burden, in self protection.

When the great war broke out, the supply of basic refractories promptly was limited, due primarily to the stoppage of Austrian magnesite exports, and the result was an increased use of the acid process. The acid process, whether converter or open hearth, calls for the use of raw materials low in sulphur and phosphorus, and early in 1915 it became evident that low phosphorus pig iron soon would reach unheard of prices. In fact, prices which had been fairly steady at $16.00 per ton began climbing and never stopped until late 1920 when a maximum of $57.00 per ton was reached.

The author is president of the Tropenas Co., engineers, 2243 Nostrand avenue, Brooklyn, N. Y.

Prophetic Accidents

EVERYONE is not so gifted as to take the utmost advantage of an untoward event. Had the windblown British pippin fallen on another than Sir Isaac Newton's ample brow, the force of gravity might have remained unadvertised for centuries. In this article, the author recounts an accidental bridging which produced converter steel from a small cupola furnace. Perhaps others have met with a similar phenomenon and a comparison of experiences may open the way to a wider application of the foundry's most used melting medium—the prosaic cupola.

Needs Force Scrap Use

To those of us who are interested in converter operation, the proposition became one of life or death, and means had to be provided promptly to do away with the use of low phosphorus pig iron. Steel scrap being the only possible substitute, our efforts naturally centered in the melting of increasing percentages of scrap in the cupola.

In the rear of our office building we have a combination garage and miniature foundry, the melting equipment consisting of a 12-inch home-made cupola. The blast is supplied underground from the basement in our office, by a small Roots blower.

To our gray iron friends who seldom use anything smaller than a 30-inch cupola, it will seem that no small amount of nerve was required to experiment on all steel scrap cupola melting in a 12-inch baby cupola. However, the year 1915 was no time to ask favors of friends and the idea of inducing anyone to give us the freedom of their foundry for experimental purposes was out of the question. Therefore, we started to melt 40 per cent steel scrap in the 12-inch cupola and after many instances of the usual freezing on the hearth when scrap burdens were increased, we succeeded in melting 100 per cent steel scrap in the baby furnace.

It is needless to say that cupola practice when melting all steel scrap, does not resemble the usual procedure, and new standards had to be developed to insure a continuous liquid stream at the tap hole, without the often encountered freeze up at the breast.

Here we can best quote the specifications of patent No. 1,336,256 issued on April 6, 1920, to E. Roubieu and the writer:

In melting steel scrap not only is a higher temperature necessary than for melting pig iron, but also a greater quantity of fuel than is necessary to produce that higher temperature, since the steel absorbs from the fuel a certain amount of carbon, which otherwise would contribute to increase temperature. In other words, fuel must be supplied in sufficient quantity not only to supply the inevitable recarburization of the steel but also to fuse the metal at a temperature high enough to maintain it in molten condition on the hearth of the cupola and prevent it from solidifying there. This trouble has been understood and it has been attempted to meet the situation by increasing the amount of fuel which usually is inserted between alternate charges of metal. For the reason hereafter explained, this has failed to accomplish the desired result, and it has become general practice to use only a slightly increased amount of fuel and to limit the proportion of scrap to pig iron to from 30 per cent to 40 per cent of scrap to 70 per cent to 60 per cent of pig and even a lower proportion of scrap in order to keep the molten product from solidifying on the hearth. Furthermore, the practice heretofore followed has been to charge the scrap directly upon the fuel and the pig above the scrap, with the thought that the pig would melt first and run down through the scrap and thus aid in the fusion thereof.

Our investigations have disclosed that the practice heretofore followed has been defective in several respects: First, by reason of failure to heat properly the hearth of the furnace before actual melting is begun; second, in failing to subdivide the alternate charges of metal and fuel to a sufficient extent to obtain the desired result; and third, in failure properly to charge the metal upon the fuel bed or fuel charges.

When the usual full-sized charge of metal is fed to the cupola and contains a large proportion of steel scrap, the increased amount of fuel required to melt and recarburize the steel scrap is too

deep to be completely ignited simultaneously throughout its depth, with the result that the lower portion of the fuel is reduced to ash before the upper portion is fully fired and the portion first burned is exhausted without accomplishing any perceptible fusion of the superimposed charge of metal. Second, when the upper portion of the fuel bed incandesces and reaches the temperature necessary for the fusion of the metal charge, it possesses too little body to melt the scrap and bring it to the high temperature necessary to maintain it in fused condition when it falls upon the hearth. We have found that this difficulty is eliminated completely by subdividing the charges. If, for instance, the normal charge is 1200 pounds of metal, we divide this in half and make our charges 600 pounds of metal and in like manner halve the fuel charge, so that if the latter comprises normally 120 pounds of coke, we use for our sub-divided charge, say 60 or 65 pounds of coke. Moreover, we have discovered that the assumption that the pig will melt first when charged above the scrap, is erroneous and that in fact the scrap melts first and the pig afterward so that no advantage is obtained by charging in the customary manner, but on the other hand an advantage is lost since if pig iron is charged directly on the fuel, its fusion produces a bath of metal on the hearth which owing to its high temperature and its lower solidifying point will aid in maintainng the subsequently melted and recarburzed steel scrap on the hearth in the proper fused condition.

Moreover, by charging the pig first, it is assured that the molten product on the hearth and at the tap hole is of such character that it remains in fused condition at a lower temperature than the molten scrap and so prevents the formation of a solid or semiplastic plug at the tap hole thus affording easy tapping—a most important consideration. If the metal falling first on the hearth is the fused scrap, which requires a high temperature to maintain its fused condition, it is extremely likely that a plug of solidified metal will form at the tap hole which cannot be punctured by the tapping bar, with the result that the entire molten mass solidifies on the hearth of the cupola before it can be withdrawn.

Differences Are Marked

Other variations from established practice will be observed from the following example of the manner in which melting is accomplished in accordance with our process. Assuming the cupola to be empty and the lighting and the tap holes at the hearth level are open, a fire is built upon the hearth and a suitable fuel bed extending from 12 to 14 inches above the top tuyeres laid upon it. This is ignited and after it is well fired, a 2½ to 3-foot layer of fuel is charged and the blast applied. The fresh fuel forms a cork or plug which forces the heat down upon the hearth, the lighting and tap holes still being maintained open to permit the escape of the products of combustion. This preliminary heating of the hearth, which is continued for 15 to 25 minutes, brings the hearth to a high temperature, which is desired for the reception of the molten metal. A further supply of fuel then is charged upon the fire bed, if necessary, to bring the upper level of the fuel to the melting zone, that is to say, 14 or 15 inches above the tuyeres and the lighting door and the tap hole are closed so that the products of combustion will pass normally upward to the stack. Upon this fuel we charge a small quantity of steel scrap. Assuming the cupola to be 36 inches in diameter inside the lining, of a capacity of about 5 tons per hour, the first metal charge would be about 200 pounds of pig iron followed by 400 pounds of steel scrap, instead of the usual charge of 1200 pounds of metal. Upon this we add a layer of fuel, say 65 pounds of coke then a layer, say of 600 pounds, of scrap, and so on. As the charges move downward through the melting zone above the tuyeres the relatively thin fuel beds are quickly and completely ignited throughout their depth and give their entire heat to the superimposed charge of metal which fuses rapidly so there is practically no interruption of the rain of molten metal to the hearth.

Supply Priming Charge

Owing to the high temperature of the fused scrap and the relatively low melting point of the primer of pig iron, the resulting molten product has no tendency to solidify or the tap hole to become choked. The charges of scrap may succeed each other continuously without interruption as long as the operation of the cupola is continued and in this case the proportion of the original quantity of priming pig to scrap is negligible. However, if the operation is interrupted, a priming charge of pig iron is introduced at such a time that its subjacent fuel bed reaches the melting zone almost simultaneously with cutting off of the blast, so that it is in position to form a primer when the operation of the cupola is resumed. When the cupola is associated with a converter, the successive charges are so calculated that upon the halt of the operation of the cupola, a priming charge of pig iron will be in a position to enter the melting zone when the blast again is started. Preferably each charge will comprise a small proportion of pig iron to steel scrap so that the blast may be cut off at any time and the presence of priming pig assured when the blast is started again.

While any suitable metal may be employed for the primer, it is an added economy to use a portion of one of the melts of the preceding day; thus a few special charges may be melted at the end of every day and divided into small portions and these portions used to form the primers for the operations of the next day. This is merely a matter of added economy since the cupola product is less expensive than pig iron. Ferrosilicon is preferably used as a primer where the cupola is associated with a converter for the production of steel, as this special pig iron supplies the necessary amount of silicon in the molten product to insure satisfactory refining in the converter. We also prefer to use steel scrap low in phosphorus and sulphur inasmuch as no refining for these elements is contemplated in the converter. Of course, it is understood that ingredients may be added as necessary to vary the product as may be desired for different types of iron or steel.

Typical Charge Suggested

As an example of suitable charges for a 36-inch cupola associated with a converter for the production of steel, the following may be given, using standard 9 per cent ferrosilicon:

CHARGE FOR 9 PER CENT FERROSILICON

Per cent	Pounds		Silicon Per cent
8	50	priming pig at	1.5
19	115	ferrosilicon at	9.0
73	435	steel scrap at (about)	0.2
100	600	converter charge at (about)	2.0

Using 12 per cent standard ferrosilicon the following proportions would be utilized:

CHARGE FOR 12 PER CENT FERROSILICON

Per cent	Pounds		Silicon Per cent
8	50	priming pig at	1.5
14.5	87	ferrosilicon at	12.0
77.5	463	steel scrap at about	0.2
100	600	converter charge at about	2.0

Preferably each charge will contain substantially the proportions specified where the cupola is used in association with a converter.

Where the cupola is used for gray iron or malleable iron foundry work the first one or two charges will comprise, about 15 per cent pig iron and 85 per cent steel scrap, and thereafter steel scrap alone, adding suitable ingredients, depending upon the character of the final product desired. It is possible in any case to use a high percentage of pig iron in the initial one or two charges and a higher proportion scrap in the later charges, but this is not safe when the cupola is associated with a converter, unless the number of charges for a blow of the converter can be predetermined with accuracy and a suitable primer of pig iron charged in position to initiate the succeeding operation of the cupola after

it has been halted temporarily to draw off for the converter.

It is well known that while searching for certain results, many things of interest crop up on the way. One *accident* brought gladness to our hearts and led us for a time to deviate from the plans we had laid down at the beginning of the experiments.

One day, while we had lapsed in the usual precautions to prevent scaffolding of our charges, the latter *arched* for quite a time, not as would be the case in a larger cupola; but the speed of descent was such as might be encountered in a combination cupola and converter. In other words, when we tapped the cupola we actually obtained steel of excellent quality. Therefore, we decided to reproduce the *accident* as a continuous process; but to this day we have failed.

To those who like to blaze the trail in things metallurgical, here is an unexploited gold mine. We have done our share in the endeavor to produce *steel* direct from the cupola, and as time, means and opportunity to continue research are not available to us, we will leave the solution of this problem to others with our best wishes.

Many countries are devoid of a steel industry and rely therefore entirely on imports for their needs. This means that in those countries, steel scrap fast accumulates and, for lack of a market, goes begging. In certain South American countries, we produce steel from local scrap at half the costs of Pittsburgh, and this example alone will help one to realize the incentives we had in carrying on the experiments outlined above.

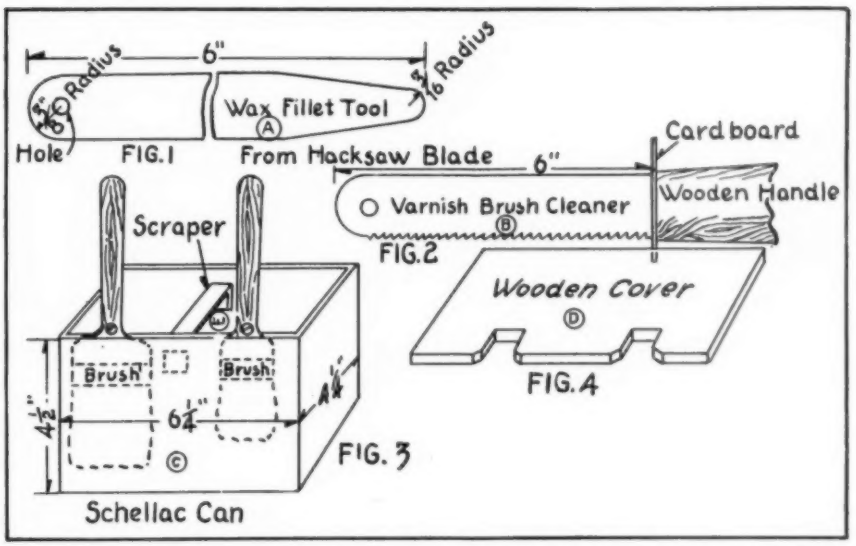


FIG. 1—WAX FILLETING TOOL AND FIG. 2—BRUSH CLEANER, BOTH MADE FROM HACK SAW BLADES FIGS. 3 AND 4—SHELLAC HOLDER AND COVER RESPECTIVELY

Homemade Tools for the Patternmaker

By M. E. Duggan

Wax fillet tools made from hack saw blades are strong, light, take a high polish, and the temper is not affected by the heat of the alcohol lamp. One of these handy little tools made from a 14-inch hack saw blade for rubbing in wax fillets is shown in Fig. 1. It was cut 6 inches from the end of the saw blade, one end is ground to any desired radius and the other end retains the hole by which it may be hung up.

Fig. 2 is a handy tool for cleaning varnish deposit and gum from patternmaker's varnishing brushes. It is made from a 14-inch hack saw blade, preferably a new one. The blade is inserted in a wooden handle as shown in the illustration. In practice the brush is removed from the varnish can, the hairs laid flat on a board and the saw teeth drawn over them, starting at the handle and working toward the tip of the brush. A small piece of cardboard pushed over the blade at the handle serves as a shield and keeps the handle clean. A dirty brush may be cleaned in a few minutes with this device.

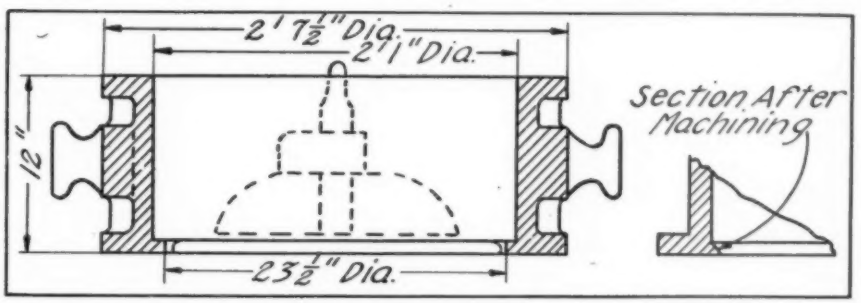
An easily made shellac container is shown in Fig. 3. Shellac for many pattern shops is purchased in gallon cans. These cans are made specially for the purpose and measure about 4¼ x 6¼ x 9 inches. An empty can may be cut down to about 4½ inches with a tinners snips or a pair of ordinary shears. The metal is quite soft and easily cut. Bend a piece of tin or brass strip, or wire and place it across the can as shown at *E* Fig. 3. The shellac on the sides of the can will anchor it in place. A screw in the handle of each brush serves to hold it at any predetermined height. A wooden cover Fig. 4 will keep the contents clean.

The Kirk Supply Co., Farmers Bank building, Pittsburgh, sellers of foundry equipment and supplies, has been appointed representative in western Pennsylvania for the Louis E. Strong Packing Co., New York, general line of packings.

Change Flask Design to Insure Clean Draw

By E. J. Edwards

Some time ago I was called upon to adjust a jar-ram molding machine, so that the sand when drawn from the pattern, would not break away between the edge of the mold and the sand strip on the bottom inside edge of the flask. Then consensus of opinion of those interested was that the machine in some matter was to blame. Having satisfied myself that the machine apparently was O K in every way, I looked for trouble elsewhere. A mold was rammed by hand, particular care being taken to see that the thin body of sand between the pattern and the sand strip was rammed hard and firm. No trouble was experienced with the mold made in this manner. The natural deduction was that the close proximity of the pattern flange to the sand strip prevented the sand from packing properly, and therefore it broke away when the pattern was drawn. The sand strip on all the flasks involved then was machined as shown in the small illustration to the right and no further trouble was experienced on this particular job.



SPACE BETWEEN SAND STRIP AND PATTERN TOO NARROW TO PACK PROPERLY CHANGING STRIP AS SHOWN IN SMALL BROKEN SECTION SOLVED PROBLEM

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Holding the Come-Again Customer

STRANGE visions were the portion of those who wore the rose-tinted spectacles of the post-war period of prosperity. Many a hard headed business man, by nature a little short sighted, donned the glasses to study his policies and could see no further than the end of his nose. Orders were plentiful, customers were clamoring for goods, so the principle of *good enough* supplanted the sound doctrine of the *best we can do*. No single class, nor group, neither manufacturer nor workman, merchant nor salesman, alone absorbed this feeling. It permeated all, though each ascribed it to others. The salesman who cynically sold an overcoat of shoddy, cared not if the purchaser came again. The cylinder which sweated under the hydrostatic test was immersed in the salammoniac tank to rust tight its open pores. What of it? If this customer would not take it, another gladly would contract the tonnage lost. If one foundryman rejected shipments for slight variations in analysis of pig iron, others would take it from the producer at an advance over the contract price. Of course, many exceptions are noted to all these instances; but the tendencies were present to a large degree, and many transactions were made with an eye solely for immediate profit.

When the glowing vision of prosperity was swept away by the period of depression, a new perspective was unfolded. The importance of the immediate sale dwindled to its proper relation viewed beside the volume of repeat orders. Once again the value of the purchaser who comes again and again, was appreciated, and quality assumed rank in the order of business. The salesman deigned to advise his customer, that the latter might be satisfied with the service of the goods he bought. Keen scrutiny was applied to the procedure of each foundry to root out prevalent casting ills. Off-iron again was relegated to a lower place on the scale of prices, and shipments were made as contracted and specified.

The lesson of the industrial and business depression has been sharp. The present period of prosperity will try its teachings. The value of the customer who returns again has been demonstrated in every line and the ways to hold his allegiance require the most careful attention. For the foundryman, the first and paramount principle should be to sell him castings at a price which will admit of a fair profit. This in turn will permit quality to be maintained. Further, promises made as to deliveries should be kept faithfully, for conscientious performance of contracts has meant much in the lean months just past. An example is cited of an eastern jobbing foundry which maintained part time operation in contrast to hundreds which were closed, solely through its known ability to deliver good castings on the day that they were promised. Its main sustaining customers, old established concerns, faithfully withstood the temptation of lower prices from competing shops, because the reputation of this jobbing foundry was unimpeached on the score of good work, delivered on the date when it was promised.

Trade Outlook in the Foundry Industry

RECAPITULATION indicates that the past year has surpassed all expectations in the volume of manufacture, and that the foundry industry has partaken of its share of the nation's business. In fact, the general belief prevails that 1922 almost doubled the tonnage record of castings in practically all lines. A comparison just issued by the department of commerce shows that in the past year a total of 2,789,371 baths, lavatories and sinks were made compared to 1,852,219 in 1921. Although complete statistics are not available, the volume of manufactured articles into which castings enter, demonstrates that this ratio has been maintained in other lines.

Auto Output Large

Preliminary figures show that the total production of passenger automobiles will exceed 2,350,000 and of trucks, 250,000, bringing the grand total for the year well above 2,500,000 cars. November set a new record for winter time manufactures, a total of 235,854 vehicles being made as contrasted with 106,042 for the same month of 1921. Releases on contracts are coming in rapidly to automobile cylinder foundries, indicating a decided demand for the late winter and early spring. Complete records of railway car purchases in 1922 show the year just past to have been the most active in the last ten years. The total awards were 180,465 cars. December showed 23,255 cars placed and was the second largest in this regard in the year. Further, the buying has continued over into the new year, inquiries in the West alone totaling over 2600 cars. The shipments of locomotives in December were the largest since January, 1921, and totaled 210. The total shipments of locomotives for the year, according to the department of commerce was 1274.

Construction Sustained

The present winter has broken all precedents in sustained building operations. Many larger jobs have been continued straight through while residence work is getting under way far in advance of the regular time for such undertakings. The result has been a continued demand coming to foundries making domestic sundries, sanitary ware, furnaces, soil pipe and plumbing goods. An exception is noted in exclusive stove shops, which in some instances are closed for inventory and will not resume operations until about the middle of February. In general, a most healthy tone is evident among jobbing foundries, though some which have been engaged upon contract work for large establishments which have found it more profitable to farm out their castings rather than to operate their own foundry departments part time, again are making ready to do their own work. Agricultural implement manufacture promises well for the present year. In consequence, castings contracts for this class of work are being closed in various sections. Cast iron pipe demand is increasing, many municipalities anticipating needs.

Prices Are Rising

Pig iron prices show tendencies toward advancing still further, some little increase having been made since the middle of December. With few exceptions no contracts for iron are being made or sought either by producers or consumers, beyond the first quarter. Some disquiet with regard to the coal mining situation is responsible for this attitude on the part of furnace interests. Coke prices are higher and shipments are hampered by the customary seasonal shipping difficulties. Though freight movements have been handled rapidly in many sections, a car shortage is arising in the east and particularly in the coke producing regions and this has been complicated by storms. The demand for coke for domestic use has exerted an influence upon foundry and furnace coke prices and supplies. This may in turn result in restricting the production or advancing the cost of manufacture of pig iron. The December output of pig iron, according to statistics compiled by the *Iron Trade* was 3,086,968 tons, the highest since October, 1920. This shows an increase of approximately 240,000 tons over the November production. Merchant iron made in December totaled 662,743 tons, compared with 603,348 tons in the previous month. On a daily average basis, this represented 21,379 tons per day as compared to 20,111 tons for November, giving an increase of 1268 tons per day. Blast furnaces operating on the last day of December numbered 250, as compared to 240 on Nov. 30. Two merchant stacks went in blast during December and none was blown out during the last month of the year.

Prices of Raw Material for Foundry Use

CORRECTED TO JAN. 11

Iron		Scrap	
No. 2 Foundry, Valley	$27.00 to 28.00	Heavy melting steel, Valley	$22.00 to 22.50
No. 2 Southern, Birmingham	23.00 to 25.00	Heavy melting steel, Pitts.	21.50 to 22.00
No. 2 Foundry, Chicago	28.50 to 29.00	Heavy melting steel, Chicago	19.00 to 19.50
No. 2 Foundry, Philadelphia	29.76 to 30.13	Stove plate, Chicago	19.00 to 19.50
No. 2 Foundry, Buffalo	27.00 to 28.00	No. 1 machy. cast, Chicago	24.50 to 25.00
Basic, Valley	26.00 to 27.50	No. 1 cast, Philadelphia	22.00 to 23.00
Basic, Buffalo	28.00	No. 1 cast, Birmingham	20.00 to 21.00
Malleable, Chicago	28.50 to 29.00	No. 1 cast, Buffalo	21.50 to 22.00
Malleable, Buffalo	28.00 to 29.00	Car wheels, iron, Pitts	23.00 to 23.50
Coke		Car wheels, iron, Chicago	26.00 to 26.50
Connellsville foundry, coke	$9.00 to 9.50	Railroad malleable, Chicago	24.50 to 25.00
Wise county foundry, coke	8.50 to 9.50	Agricultural mal., Chicago	24.50 to 25.00
		Malleable, Buffalo	21.00 to 22.00

Nonferrous Active

The first few weeks of the year have been marked by a number of small brass foundries which have been established. This in itself is an evidence of the state of business in this line of the castings industry. New York prices on nonferrous metals, based on quotations in the *Daily Metal Trade* of Jan. 11, follow: Casting copper, 14.25c; electrolytic copper, 14.75c; Straits tin, 39.00c; lead, 7.75c; antimony, 6.62½c; aluminum, No. 12 alloy, open market, 21.50c. Zinc is 7.00c, E. St. Louis, Ill. The average prices on nonferrous metals for December follow:

(New York Quotations)

Casting Copper	Electro Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
13.821	14.316	7.237	37.65	6.341	22.50	8.143

Comings and Goings of Foundrymen

M. W. ZEMAN has been promoted from the position of European sales director of the Osborn Mfg. Co., Cleveland, to be sales manager of the machine division of the same company. H. R. Atwater, vice president of the company, having withdrawn from this work to remove to California on account of ill health. Mr. Zeman has had marked success in his European work and is amply fitted for his new position. Following a survey made by E. S. Carman, secretary and chief engineer of the Osborn company, who went to Europe in January, 1919, with the special delegation from the Cleveland chamber of commerce, Mr. Zeman took up the introduction of Osborn molding machines abroad, making his headquarters in Paris. From this location he has worked with the European agents of the company in France, Belgium, Switzerland, Italy, Spain, and England. His thorough knowledge of engineering, foundry practice, and pattern making, together with his familiarity with modern molding machine equipment, has enabled him to render a peculiar service to these European countries at a time when, while much over-stocked with machine tools, they were in positive need of molding machines. Mr. Zeman was born at North Ridgeville, O., in 1886. After completing his high school education, he began his business career with the Dean Electric Co., Elyria, O., where for 5½ years he worked from a junior position in the drafting room up to that of assistant chief engineer. It was here he obtained the foundation of his engineering work, and specialized in electrical equipment. He left the Dean company and accepted a position with the American Multigraph Co., Cleveland to get the opportunity to do experimental engineering work. In his next position he had charge of the drafting room, the tool room, and later was at the head of manufacturing. Taking up his work with the Osborn Mfg. Co. in 1912, he started in the manufacturing department to acquaint himself thoroughly with every detail of the equipment. Since beginning his work with the Dean Electric Co., Mr. Zeman has completed courses in mechanical and electrical engineering, and has given 2 years of evening study to pattern making and 2 years to machine shop practice. While in the experimental drafting room of the American Multigraph Co., in addition to working on new designs and experimental improvements, he checked all patterns before going to the foundry, both for experimental castings and for regular manufacture. This company required that all castings be designed without loose pieces or cores and made as simple as possible for molding. This required a good knowledge of foundry practice and offered opportunities for education.

M. W. ZEMAN

J. L. Jones has resigned his position as foundry superintendent with the Jahns Cylinder Grinding & Foundry Co., Los Angeles, Cal.

William H. Hahn, Easton, Pa., has been made superintendent of the newly organized foundry of the Pennsylvania Electric Steel Casting Co., Hamburg, Pa.

Samuel D. Sleeth who resigned recently as general foundry superintendent of the Westinghouse Air Brake Co. at Wilmerding, Pa., has been promoted to the position of consulting foundry engineer for that company. As noted previously, Mr. Sleeth has been succeeded as foundry superintendent by F. J. McGrail.

Phillip A. Hill, who has been connected with the National Malleable Casting Co. in the Chicago district for a number of years, has affiliated with the sales department of the Superior Steel Castings Co., Benton Harbor, Mich. Having had contact with the operating, production and sales departments his experience has covered a wide range. His headquarters will be at Benton Harbor.

Talks to Quad Foundrym

E. W. Smith of the Chicago Foundrymen's club, who recently has developed a simple method of physically analyzing molding sands in the foundry, has been invited by the Quad City Foundrymen's club at Moline, Ill., to repeat the lecture he gave during December before the Chicago club and to exhibit his samples of sand from all over the country. The Quad City Foundrymen's club is a newly organized association of foundrymen in Moline, Ill., Rock Island, Ill., Davenport, Iowa and East Moline, Ill. Its meeting to listen to Mr. Smith will be held Jan. 20.

Will Give Address on Foundry Problems

Strength in Castings—Cupola Practice, is the subject of a paper to be presented by E. J. Lowry, metallurgist of Hickman, Williams & Co., before the members of the Pittsburgh Foundrymen's association this month. This regular monthly meeting and dinner will be held Jan. 15 at 6:30 p. m. at the General Forbes Hotel, Pittsburgh.

Appoints Representative

W. S. Murrian, formerly superintendent of motive power of the Southern railroad, together with his two sons, James A. Murrian and John H. Murrian, transacting busines under the name of the W. S. Murrian Co., at Knoxville, Tenn., have been appointed by the Mahr Mfg. Co., Minneapolis, as field representatives for southeastern United States.

Take Over Business of Blower Firm

The Swartwout Co., Cleveland, organized by the former president and secretary of the Ohio Body & Blower Co., Cleveland, has taken over the latter's plant at Orville, O., together with a plant in Cleveland formerly occupied by the Cleveland Milling Machine Co.

The new company will engage in a

metal stamping business, producing ventilators, core ovens, enameling ovens, metal buildings, steam specialties, exhaust heads, steam and oil separators, steam traps and feed water heaters. The Blower company will continue to manufacture automobile bodies.

Officers of the company are: President, D. K. Swartwout, formerly president of the Ohio Body & Blower Co.; vice presidents, W. M. Pattison, head of the Pattison Supply Co., Cleveland, and D. K. Swartwout Jr.; secretary and treasurer, W. E. Clement, formerly secretary of the Ohio Body & Blower Co.

Number of Pumpmakers Increases

One hundred and thirty-five manufacturers were making steam and other power pumps in 1921 compared with 112 in 1919, but the value of their products was only $47,239,000 in 1921 as against $53,746,000 in 1919, according to the census bureau. The number of persons engaged in the industry was 11,409 in 1919 and 13,286 in 1921. Their salaries and wages aggregated $17,179,000 in 1921 and $18,799,000 in 1919. The cost of raw materials used was $18,676,000 in 1921 compared with $23,908,000 in 1919.

Build Modern Foundry in West Virginia

A modern electric steel foundry soon will be erected at Parkersburg, W. Va., for the Blackwood Electric Steel Corp., of that city. The design and supervision of the plant is being handled by Mills Rhines, Bellman & Nordhoff, engineers, Toledo, O. The structural steel contract has been placed and the remainder of material will be contracted for soon, so that the plant can be constructed immediately and put in operation in the early spring.

Grinding Wheel Plant Purchased

The Cleveland Stone Co., Cleveland, has purchased the plant and equipment of the Sterling Grinding Wheel Co., and will enter the field of artificial abrasives.

New Shop in Somerville

The F. H. Stevens Co., Boston, has recently built a factory in Somerville, a suburb of Boston. The company will manufacture type and printing machinery. It has lately moved its Boston office from 165 High street to 110 Broad street. F. H. Stevens Jr., is president and F. H. Stevens Sr., is vice president and general manager.

H. R. Atwater Removes to California

H. R. Atwater, vice president of the Osborn Mfg. Co., Cleveland, has resigned his position as sales manager of the machine division of that company and is succeeded in this position by M. W. Zeman. Mr. Atwater having suffered from ill health for more than a year decided to give up the strenuous work of sales manager

H. R. ATWATER

and recently has removed to California to live. Here he will look after the company's molding machine interests on the Pacific Coast, having retained the position as vice president of the company. Mr. Atwater's health has decidedly improved since his removal to California, where he is enjoying golf and other recreation.

Mr. Atwater became connected with the Osborn Mfg. Co., in October, 1893, at the age of about 27 years, having spent most of his earlier life in the brush and broom business. His connection with the Osborn company induced that firm to add to its former line of wire brushes, brooms, and foundry supplies, the manufacture of bristle and fibre brushes. After getting the manufacture of these well under way, Mr. Atwater transferred his efforts to sales work, and it was through his close contact with many of the leading foundrymen of the country that the Osborn Mfg. Co. was led to enter the molding machine field. Mr. Atwater has had a large part in the development of the line of molding machines made by the company, and from the time it started to manufacture molding machines he has been at the head of the machine sales department.

Obituary

Samuel Raynor, assistant treasurer of the Builders Iron Foundry, Providence, R. I., died at his home in that city Dec. 26, aged about 50 years. He had been with the company 20 years.

H. Rowland Curtis, aged 54 years, treasurer of the National Malleable Castings Co., Melrose Park, Ill., was instantly killed Jan. 3 by an automobile near his home while crossing the street.

John H. Bass, founder of the Bass Foundry & Machine Co., Fort Wayne, Ind., died December 17 at his home in Fort Wayne, aged 87 years.

Louis C. Sands, aged 64 years, vice president and general manager of the Oil Well Supply Co., Pittsburgh and Oil City, Pa., died Nov. 5. He had been associated with the supply company for 36 years. Mr. Sands was born in Greenport, Long Island, N. Y., in 1858. After completing his schooling he enlisted in the United States navy. In 1885, after receiving an honorable discharge from the navy, he began his career with the Oil Well Supply Co. In 1903 he was elected secretary, and in 1908 became vice president and general manager.

Frederick Metcalf, vice president of the Madison Foundry Co. and treasurer of the Chase Machine Co., both of Cleveland, died Dec. 8 after a three weeks illness. He was 56 years old and a native of Providence, R. I. He went to Cleveland in 1898. He was a graduate of the Massachusetts Institute of Technology and from 1895 to 1898 was treasurer of the American Ship Windlass Co., Providence.

Jacob E. Snyder, 77 years old, vice president of the Hess-Snyder Co., Massillon, O., died recently at his home in that city. Mr. Snyder entered the manufacturing business in 1872 when he became associated with F. H. Snyder & Bros. in operating a general jobbing shop. Ten years later the firm of which he was a member consolidated with J. H. Hess & Bros., manufacturers of stoves. Mr. Snyder was chosen vice president of the company shortly after its incorporation and retained that office until his death. In addition to being associated with the Hess-Snyder Co. he was interested in several other machine manufacturing factories and with steel making companies in the Canton district.

Equipment Sales Start Slowly

Although Buying Is Light in Foundry Machinery and Sundries, Prospects for Increased Business Are Plentiful — Cupola Sales in Western Territory Prove Exceptional

TRUE to expectations, the first weeks of the new year have been marked by few important inquiries for or sales of, foundry equipment. This was presaged by the heavy buying just preceding the close of the past year, and further by the lull which always prevails at inventory time. However, the volume of inquiry for sundries, together with the promise of increased foundry operations during the next few months furnishes a sound basis for the feeling which prevails among equipment manufacturers that the late winter and early spring will be marked by exceptional business. Many changes and new enterprises are noted, particularly in the establishment of small shops. An outstanding example of the former is the establishment of the Eastern Foundry Co., Boyertown, Pa., which is building a soil pipe foundry. Associated in this firm are E. M. Rhodes, president, formerly president of the Sanitary Co. of America, Linfield, Pa., B. W. Frederick, vice president, Grant P. Bechtel, secretary and Daniel G. Burkert, assistant secretary and purchasing agent. Harry R. Trout will be general superintendent. The Hardinge Co., New York recently has orders for grinding mills to prepare enamel, from the Porcelain Enamel & Mfg. Co., Baltimore, the Humphryes Mfg. Co., Mansfield, O., and the United States Sanitary Mfg. Co., Monaca, Pa. The department of commerce reports an inquiry for foundry installations for making brass and malleable castings from Greece. Details may be obtained by refering to No. 4569 at the nearest chamber of commerce of the larger cities. The Pangborn Corp., Hagerstown, Md., recently has received orders for sand blast machinery from the Buick Motor Co., Flint, Mich., the Fairbanks Co., Springfield, O., and Aultman & Taylor Co., Mansfield, O. F. J. Ryan & Co., Philadelphia, have contracted with the Blackwood Electric Steel Co., Parkersburg, W. Va., to supply the annealing, core oven, oil and air distribution and pyrometer equipment.

Buying Slow to Start in the East

DUE to inventory and other seasonal causes, buying of foundry equipment has not reached the swing that is expected to develop by the first of February, when trading is likely to become as active as it has been for several months. Prospects for the first half of this year are regarded as quite good, but it is generally conceded that it will take a little time for the brisk business expected to get under way. At present, little that has not already been mentioned in this column previously is promised in the way of new construction, but this also is not surprising, as the general building season is still some two months or so in the offing. Orders, generally, are for replacement purposes, although some buying is for new additions completed or under way. The American Locomotive Co. continues to be a buyer of equipment for its new addition at Schenectady, N. Y., and is also contemplating the purchase of some foundry equipment for two or three of its other plants. The M. W. Kellogg Co., Jersey City, is buying additional equipment for its new foundry now nearing completion. It recently purchased a 5-ton, 2-motor crane with 30-foot span, from the Roper Crane & Hoist Works, Reading, Pa., for its charging floor, and has still several other items pending. The United States Sanitary Mfg. Co., Monaca, Pa., and the American Metals Co. have each purchased a cupola from the Whiting Corp. The latter is for installation in Mexico. The A. P. Smith Mfg. Co., East Orange, N. J., has recently purchased some molding machinery and a mixer and is contemplating the installation of further molding equipment in the near future. The Eastern Steel Castings Co., Newark, which is the reorganization of the Bayonne Steel Castings Co., Bayonne, N. J., formed to take over the Newark plant of the American Brakeshoe & Foundry Co., and operate it as a steel foundry, continues an important prospective buyer. The American Steel Foundries, Chester, Pa., has purchased two 75-ton trolleys. Equipment is to be purchased shortly by the Monessen Foundry & Machine Co., Monessen, Pa., for a new addition. Foundry equipment prices generally are unchanged, but the tendency is strongly upward. This is particularly true in conveying equipment, such as cranes, which recently were the lowest in price in more than nine months. An advance of 5 per cent has been announced by a hoist manufacturer. The Sullivan Machinery Co., Claremont, N. H., the Florence Pipe Foundry & Machine Co., Florence, N. J., and the Gleason Works, Rochester, N. Y., recently have purchased sand blast equipment from the Pangborn Corp., Hagerstown, Md.

Heavy Sales Noted in Chicago

IMPROVEMENT in activities of foundries continues and is under such headway that it did not stop for the holidays, continuing through the season when usually it slacks materially, while inventory is being taken. As an indication of the momentum it now has assumed orders for 11 cupolas were booked by one maker at Chicago the final day of the year. Demand for ladles, always a good indication of the extent of the melt of iron, continues heavy, including all sizes, shipments being made by all suppliers to all sections of the country. Other foundry supplies dependent on actual melt of iron, are active, giving further indication of the growing business being turned out. An interesting contract recently taken by the Whiting Corp., Harvey, Ill., includes an entire pulverized fuel installation for the malleable plant of the American Radiator Co., Buffao, N. Y. This includes the tank hopper, crusher, elevating equipment, Grindle dryer, Raymond high-side air separator, the pulverizing and complete firing equipment for six 30-ton melting furnaces, and also a pneumatic conveyor system for conveying powdered coal from the preparation plant to the present annealing ovens and powdered coal firing equipment for the ovens. The preparation plant will have a capacity of 10 tons per hour. Recent sales of cupolas by the Whiting Corp. include the following: National Supply Co., Toledo, two 54-inch cupolas; United States Sanitary Co., Monaca, Pa., 72-inch; Vulcan Plow Co.,

Evansville, Ind., 45-inch; Bartlett, Hayward Co., Baltimore, 72-inch, 60-inch and three 45-inch; F. D. Chase, Inc., Chicago, 66-inch; American Radiator Co., New York, two 72-inch; Regent Stove Co., Detroit, 45-inch; Iowa State College, Iowa City, Iowa, 32-inch. The same interest has sold the following tumbling barrels: Buick Motor Co., Flint, Mich., two 33 x 80-inch barrels; Ford Motor Co., Detroit, twenty 30 x 48-inch barrels and ten 42 x 72-inch barrels; Chicago Malleable Castings Co., West Pullman, two 48 x 60-inch; Diversey Foundry Co., Chicago, 30 x 48-inch tumbler; E. W. Bliss Co., Brooklyn, 60 x 72-inch tumbler; Lansing Co., Lansing, Mich., 24 x 42-inch and 33 x 42-inch. Elevators and cranes are also being bought to add to existing facilities in foundries.

The Bayer-Rothgeb Co., Los Angeles, Cal., and the Clinton Lock Co., Clinton, Iowa, have purchased sand blast equipment from the Pangborn Corp., Hagerstown, Md.

Slump Shown in Pittsburgh Sales

THE lull which has characterized the foundry equipment market in the Pittsburgh territory since the first of the year offers a decided contrast to the condition which obtained the latter part of December. At that time numerous sales were recorded in connecion with various types of foundry machinery, mainly molding machines. For instance in connection with this latter type, the Herman Pneumatic Machine Co., Zelienople, Pa., reports but one or two inquiries since Jan. 1 and no sales whatever. However, before the year closed the American Cast Iron Pipe & Foundry Co., Birmingham; the Union Tool Co., Los Angeles; the Frick Co., Waynesboro, Pa.; the Vulcan Iron Works, Wilkes Barre, Pa.; the Elizabeth Foundry Co., Elizabeth, N. J., and the Ohio Steel Foundry Co., Lima, O., each closed on single molding machine installations, most of them of the large rollover type, while the Keystone Driller Co., Beaver Falls, Pa., the American Radiator Co., Buffalo, and the American Steel Foundries, Pittsburgh, Pa., each bought two. The Kelly & Jones Co. closed upon an electric furnace and several other nearby foundry interests now have inquiries out for furnaces of this type. The United States Sanitary Mfg. Co. closed upon a Whiting Corp. cupola. This latter manufacturer reports the sale of a few ladles and the receipt of several inquiries for core ovens, tumbling barrels, etc. The Velte Foundry & Machine Co., Mars, Pa., wants machinery of this type and the Blackwood Electric Steel Co., Parkersburg, W. Va., still is understood to be in the market. The latter interest has purchased sandblast machinery from the Pangborn Corp., Hagerstown, Md. The quiet period which has prevailed since the first of January is attributed mainly to taking inventories and making various adjustments. The general feeling, however, is that 1923 as a whole will be a good equipment selling year and the consensus of opinion places the major portion of the buying within the first three or the first six months. A large number of hoists, together with a few cranes are being asked for. The Crucible Steel Co. of America is in the market for a 10-ton crane with 60-foot span and a small special crane is wanted by the Gifford-Woods Co., Oakmont, Pa. The Universal Steel Co., Bridgeville, Pa., bought a 10-ton crane from the Pawling & Harnischfeger Co., Milwaukee, which crane builder likewise received contracts recently from the Cutler Steel Co., Pittsburgh, and the Jeffrey Mfg. Co., Columbus, O., for one 10-ton crane each. The Pittsburgh Knife & Forge Co. closed on a 10-ton Shaw crane with Manning, Maxwell & Moore, Inc., and the General Electric Co., Erie, Pa., bought one each 5 and 10-ton cranes from the Northern Engineering Works, Detroit.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

An increase in capital stock, from $10,000 to $150,000, recently was made by the Semi-Steel Test Foundry Co., Chicago.

Erection of an addition to its plant is being planned by the Peru Foundry Co., Peru, Ind.

The Chapman Valve Mfg. Co., Indian Orchard, Mass., has increased its capital stock from $1,000,000 to $1,500,000.

The Hercules Foundries, Inc., Huntington Park, Cal., is building a steel warehouse, 40 x 175 feet.

The Atlas Foundry & Machine Co., Tacoma, Wash., has increased its capital stock to $82,500.

The Townsend Furnace & Machine Shop Co., Albany, N. Y., has increased its capital stock from $80,000 to $300,000.

The capital stock of the Nassau Smelting & Refining Works, Ltd., New York, has been increased from $1,000,000 to $1,500,000.

Capital stock of the Machinists Foundry Co., Muncie, Ind., has been increased from $10,000 to $100,000.

The Dean Bros. Seam Pump Works, Indianapolis, has increased its capital stock from $60,000 to $400,000.

The Fuller & Warren Co., Monroe street, Troy, N. Y., manufacturer of stoves ranges, etc., is planning to rebuild the part of its plant which recently was damaged by fire.

The capital stock of the Malleable Iron Range Mfg. Co., South Bend, Ind., recently was increased from $40,000 to $400,000.

The Louisville Car & Foundry Co., Louisville, Ky., has increased its capital stock from $10,900 to $75,000.

Fire recently damaged the plant of the John Hewitt Foundry Co., Newark, N. J. Plans for the reconstruction of the building have not been announced.

The Midwest Casting Co., Middletown, O., is reported contemplating doubling its present plant capacity. H. S. Wise is president of the company.

The Tozer Engine & Iron Works, Columbia, S. C., has been incorporated with a capital stock of $100,000 by T. P. Knox, T. F. Daily and others.

The General Smelting & Refining Co., Detroit, has been incorporated by Samuel Cooper, 678 Leland avenue, Detroit, Daniel Temehin and Cipo Cooper.

Capitalized at $60,000, the Zellner Foundry Co., Cleveland, has been incorporated by Karl J. Zellner, W. R. Brower, R. E. Sheal, M. E. Mullin and L. C. Steen.

The capital stock of the W. A. Jones Foundry & Machine Co., Chicago, recently was increased from $100,000 to $400,000. Plans of the company have not been announced.

The Hunt-Spiller Mfg. Co., 382 Dorchester avenue, Boston, manufacturer of iron castings, has started work on the erection of a 2-story addition. Wallace L. Gifford is president of the company.

The Electro-Metallurgical Co. of Canada, Ltd., Toronto, Ont., has been incorporated with $150,000 capital stock by Robert E. Laidlow, William R. West and Donald F. MacLaren.

Capitalized at $100,000, the James H. Beans Foundry Co., Martins Ferry, O., recently was incorporated by J. H. Beans, William King and others. Plant extensions are under consideration.

Capitalized at $5,000,000, the Welland Alloy Steel Corp., Ltd., Welland, Ont., recently was incorporated by Arthur R. Armstrong, William A. Werrett, George W. Hambly and others.

Plans for the erection of a foundry building have been prepared by the McWane Cast Iron Pipe Co., Birmingham, Ala. It is to be erected in East Birmingham at an estimated cost of $50,000.

The American Foundry & Casting Co., Dayton, O., has leased the plant of the Bahman Iron Works Co. for one year, en-

larged business making it necessary to occupy additional quarters.

The Birmingham Stove & Range Co., Birmingham, Ala., has tentative plans for the erection of plant extensions. The company recently increased its capital stock from $122,000 to $213,000. B. H. Jones is president of the company.

The Hendee Mfg. Co., Springfield, Mass., has purchased the property of the Harley Co., East Springfield, Mass., brass founder and drop forger, a subsidiary. The purchaser held a $625,000 mortgage on the property and bid it in at auction.

Erection of an addition to its plant, 40 x 100 feet, is being planned by the T. L. Smith Co., 1125 Thirty-second street, Milwaukee, manufacturer of castings, etc.

The Marion Foundry Corp., Auburn, Ind., has changed its name to the Auburn Foundry Corp.

Articles of incorporation have been filed by the Western Brass Mfg. Co., Milwaukee, with a capital stock of $40,000. The incorporators are Milwaukee attorneys representing the owners of the Western Brass & Aluminum Foundry Co., 241-243 Reed street, Milwaukee, which is a partnership, organized several years ago by L. H. Bierman and S. M. Liebenberg.

William J. Sweet Foundry Co., Inc., 2527 East New York street, Philadelphia, has been incorporated under the laws of New Jersey to produce nickel castings, etc., under the direction of W. J. Sweet, who was associated with the International Nickel Co. for more than 12 years. W. J. Sweet is president of the company, H. A. Cooper, vice president and C. C. Bruno, secretary-treasurer.

Phillips & Butterff Mfg. Co., Nashville, Tenn., is about ready to break ground for the erection of an additional building at its foundry. This structure, which will be three sories, 100 x 127 feet, will be used as a factory building and warehouse. The first floor will be utilized to assemble and ship hot air furnaces, while the second floor will be used for storage. The third floor will house the electro plating department.

For the purpose of obtaining additional capital to finance the erection of a plant addition, the Brantford Brass Foundry, Ltd., Brantford, Ont., recently was incorporated with an authorized capitalization of $100,000. Officers of the company are: President, D. L. Webster; vice president, A. Serjeant; and secretary-treasurer, T. E. Hutton. These men with Henry William Bennett and Donald A. Hutton, compose the board of directors.

Plant and equipment of the Royal Machine & Foundry Co., Oshkosh, Wis., recently adjudicated bankrupt, have been purchased by Walter C. Jennerjahn, who with Frank Sullivan and Emil Kieckhafer, both of Oshkosh, have incorporated the Triangle Mfg. Co., with a capital stock of $25,000 to continue the business. The Royal company maintained a gray iron foundry, machine shop and electro plating works, doing a jobbing business. The new company will carry on a similar line but expects also to make electrical supplies, tools, etc., on its own account. Mr. Sullivan will serve as factory manager. He formerly was works manager of the Oshkosh Motor Truck Co.

New Trade Publications

HOISTS—The Wright Mfg. Co., Lisbon, O., has published a small 16-page illustrated booklet in which hand-operated hoists and traveling cranes, as well as hoist accessories, trolleys, etc., are described and illustrated.

CHAIN—The Brown Hoisting Machinery Co., Cleveland, has just published its new catalog on drop forged chain for conveyors and elevators. The material given in the booklet is valuable and interesting.

HEATER—The B. F. Sturtevant Co., Boston, has published a 16-page illustrated bulletin in which unit heaters for industrial plants are described and illustrated. The illustrations are of several actual installations. Specifications are given.

WATER HEATERS—A 16-page booklet has been published by the H. S. B. W.-Cochrane Corp., Philadelphia, in which the use of heaters for protecting boilers and steel tube economizers, also the piping of heating and hot water service systems, against oxygen corrosion, is described.

DUST COLLECTING—The Dust Recovering & Conveying Co., Cleveland, has published a 4-page illustrated bulletin in which the dust collecting system in the Ford Motor Co.'s foundry is described and illustrated. Another 4-page bulletin issued by the company contains a partial list of users of dust collecting systems.

STEEL WHEELS—A 30-page illustrated booklet has been published by the Geneva Metal Wheel Co., Geneva, O., in which steel wheels of all kinds are described and illustrated. The wheels are for use on balers, barrows, carts, concrete mixers, crushers, cultivators, ditching machinery, drills, trucks, industrial trucks, etc. Construction, design and use of the various wheels is pointed out in the booklet.

SMALL TOOLS—The Western Tool & Mfg. Co., Springfield, O., has published a 96-page illustrated catalog in which its small tools and shop furniture are described and illustrated. The tools described include expanding mandrels, tool holders, lathe dogs, clamps, emery wheel dressers, vises, etc. The shop furniture consists of stands, both portable and stationary; tool boxes; trucks; shop boxes; benches; stools, racks, etc.

INDUSTRIAL EQUIPMENT—The Buffalo Forge Co., Buffalo, has published a new general catalog of its many products. It is profusely illustrated and contains 180 pages. Equipment described includes forges, hand blowers, tuyere irons, electric forge blowers and forges, post drills, hand and power drilling machines, power blowers and exhaust fans, hand and power punches and shears, bar cutters, bending machines, tire upsetters, universal woodworkers, heating furnaces, stationary forge shop equipment, disk ventilating fans, heating, ventilating, drying and mechanical draft apparatus, etc.

CRANE—The Link-Belt Co., Chicago, has published a 4-page illustrated folder in which a crane of the crawler type is described and illustrated. This crane can operate with a hook-block, grab bucket, drag-line bucket, skimmer bucket, steam shovel attachment, electric lifting magnet, wood grapple or pile driver attachment. It weighs 22 tons and can lift 10 tons at 12-foot radius, or three tons at a 30-foot radius. The boom is 35 feet in length. This crane rotates four complete revolutions per minute, travels three-quarters of a mile per hour and can climb a 20 per cent grade.

OIL BURNERS—F. J. Ryan & Co., Philadelphia, has issued an 8-page bulletin in which oil burners for all industrial heating operations are described and illustrated. The data in this bulletin have been considerably elaborated upon from the preceding bulletin on the subject. Information given includes a description of the way of determining the amount of air necessary for proper combustion and the correct proportions of air with oil.

DUST COLLECTING—A 16-page illustrated booklet has been published by the W. W. Sly Mfg. Co., Cleveland, in which the use of dust collecting equipment is described and illustrated. According to the booklet losses caused by dust include wasting valuable products, damaging machinery, causing accidents, disfiguring buildings, impairing health, decreasing plant efficiency, increasing maintenance costs and causing explosions. Each of these losses is described. The company's dust arresting equipment is described in detail, the descriptions being supplemented with half-tone illustrations nd line drawings.

PNEUMATIC COLLECTING—The B. F. Sturtevant Co., Hyde Park, Boston, has issued a 72-page bulletin on pneumatic collecting and conveying. It contains 33 pages of illustrations and diagrams, 17 pages of useful tables, such as how to find the size of fans, the suction, volume, revolutions per minute, and horsepower of any system, cubic feet of air handled per minute, size of pipe and ducts used, and many others. Data also are given on dust collecting from grinding and polishing machines, tumbling barrels, sandblast machines, coal breakers, shoe machinery and the removal of fumes, gases, etc. In addition parts of the booklet are devoted to the conveying of pulverized coal, and other materials.

ELECTRIC FURNACES—A 6-page illustrated folder is being circulated by the Electric Furnace Co., Salem, O., in which electric furnaces for melting nonferrous metals are described and illustrated. The folder tells what alloys the furnaces are melting, what products they are producing and what users think of them. In addition to this folder the company also is circulating another folder which contains a number of illustrations showing some of the many types of electric annealing and heat treating furnaces installed by the company during the past few years. These installations include ones at the plants of the Ingram Richardson Mfg. Co., the American Manganese Steel Co., Lamson & Sessions Co., Mullins Body Corp., National Malleable Casting Co., and C. H. Wills & Co.

BACK-PRESSURE VALVE—The H. S. B. W.-Cochrane Corp., Philadelphia, has published a 4-page illustrated bulletin in which a motor-operated back-pressure valve is described and illustrated. This valve is of a new type especially designed for easy regulation. A number of small disks are used instead of one large disk and each disk is held to seat by spring pressure, the pressure on all the springs being regulated simultaneously by a movable pressure plate, the position of which can be adjusted from outside the valve case. If it is desired to operate the valve from a short distance, as from the floor above or below, chain and chain wheel or bevel gear and rods can be used. In order to regulate the valve from a greater distance an improved electric motor control has been devised. The valve can be located on the tenth floor while the remote control panel is in the engine room, alongside the pressure gage. By throwing a switch or pushing a button, the operator sets in motion a motor which drives through a worm gear the pressure plate of the valve, the operator meanwhile watching the pressure gage and pulling the switch open when the right pressure is reached, or the plate can be stopped at any desired point. Other interesting details are given.